

# Dynamic Multi-Modality Fused Imaging, Analysis, Computer Aided Diagnosis System

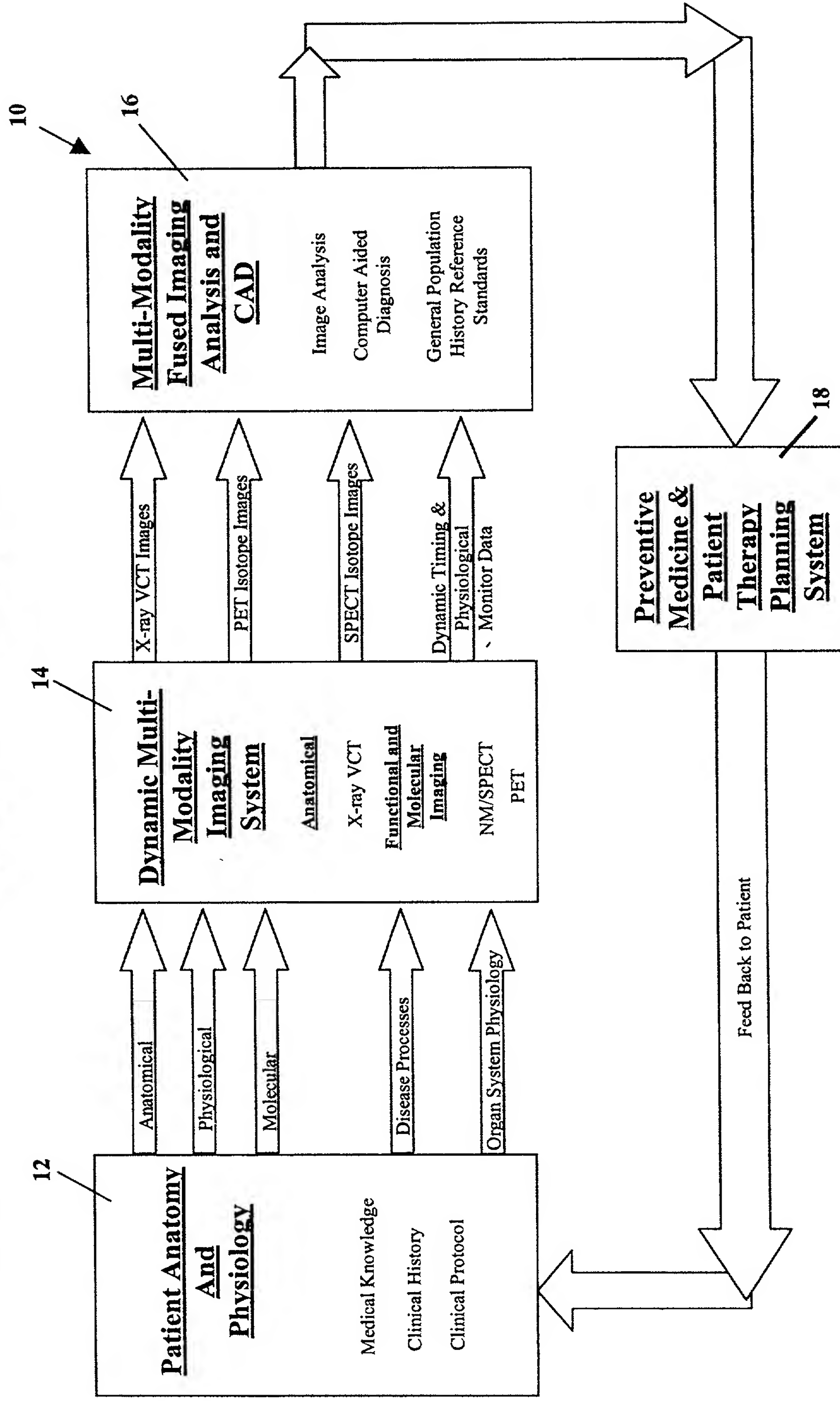
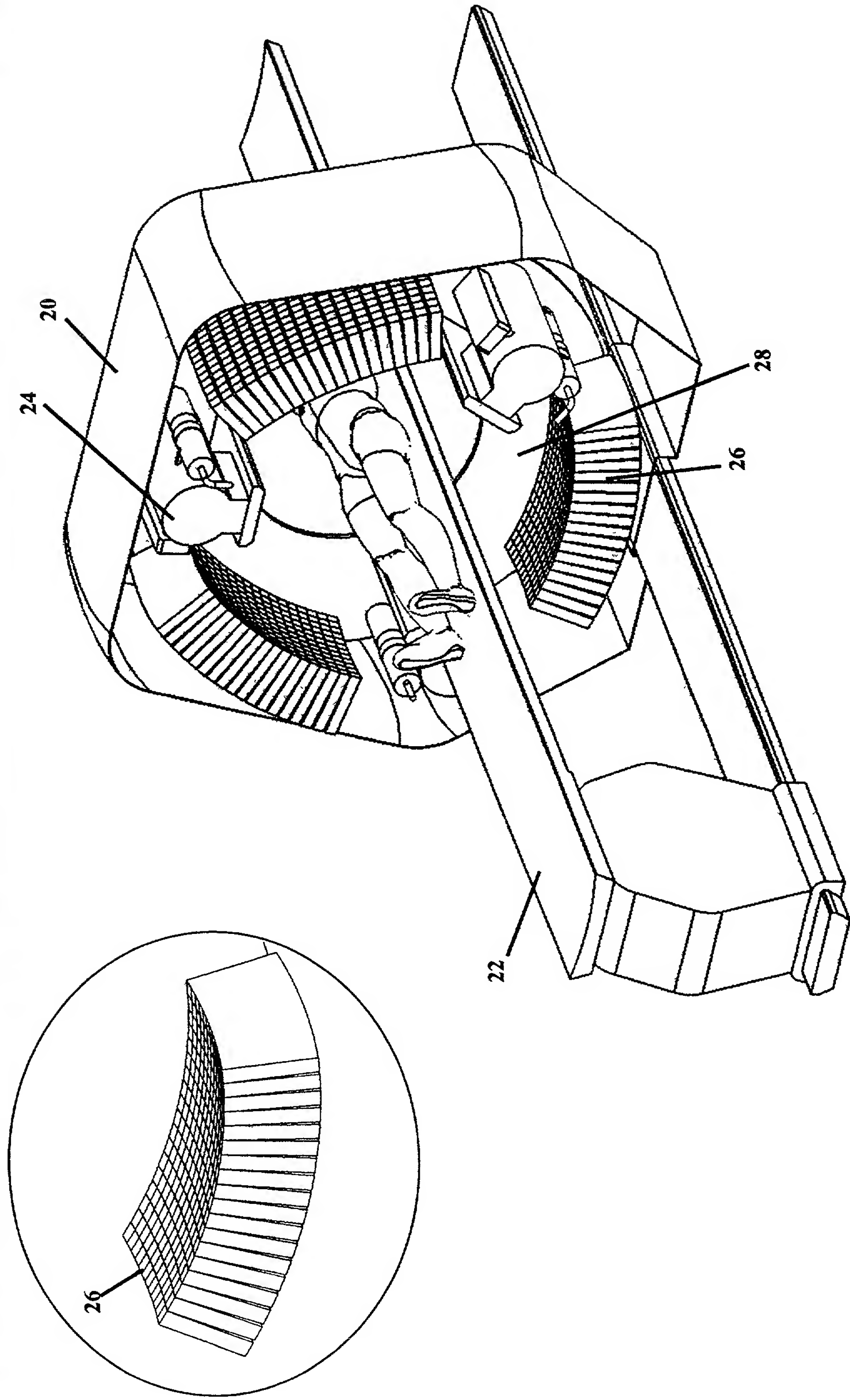


Figure 1

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# Multi-Modality Imaging System with Common Focused 2D Curved Detector



**Figure 2**

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# Overall Multi-Modality Imaging System Block Diagram

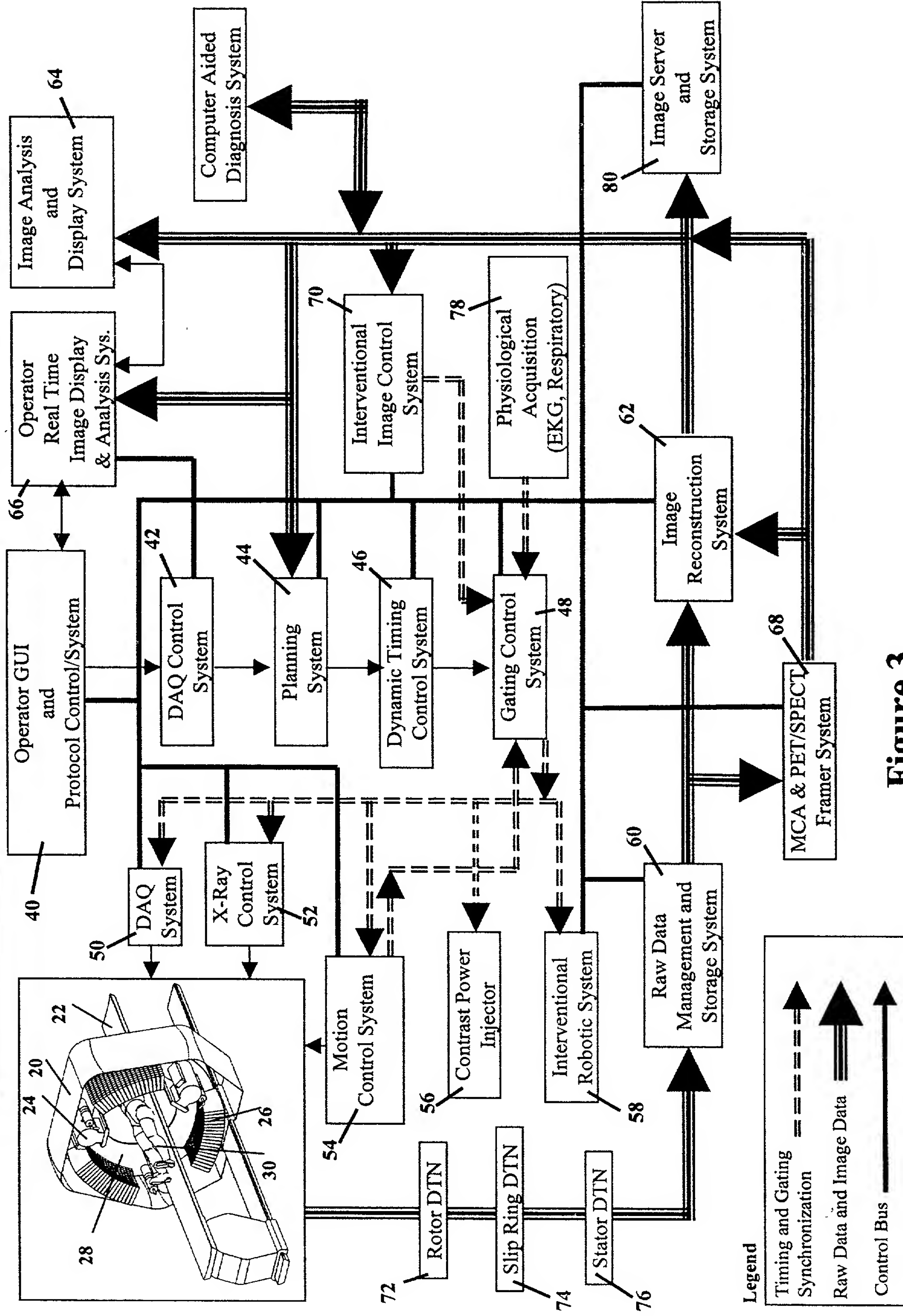


Figure 3

# X-ray & Focused 2D Curved Detector Arrangement

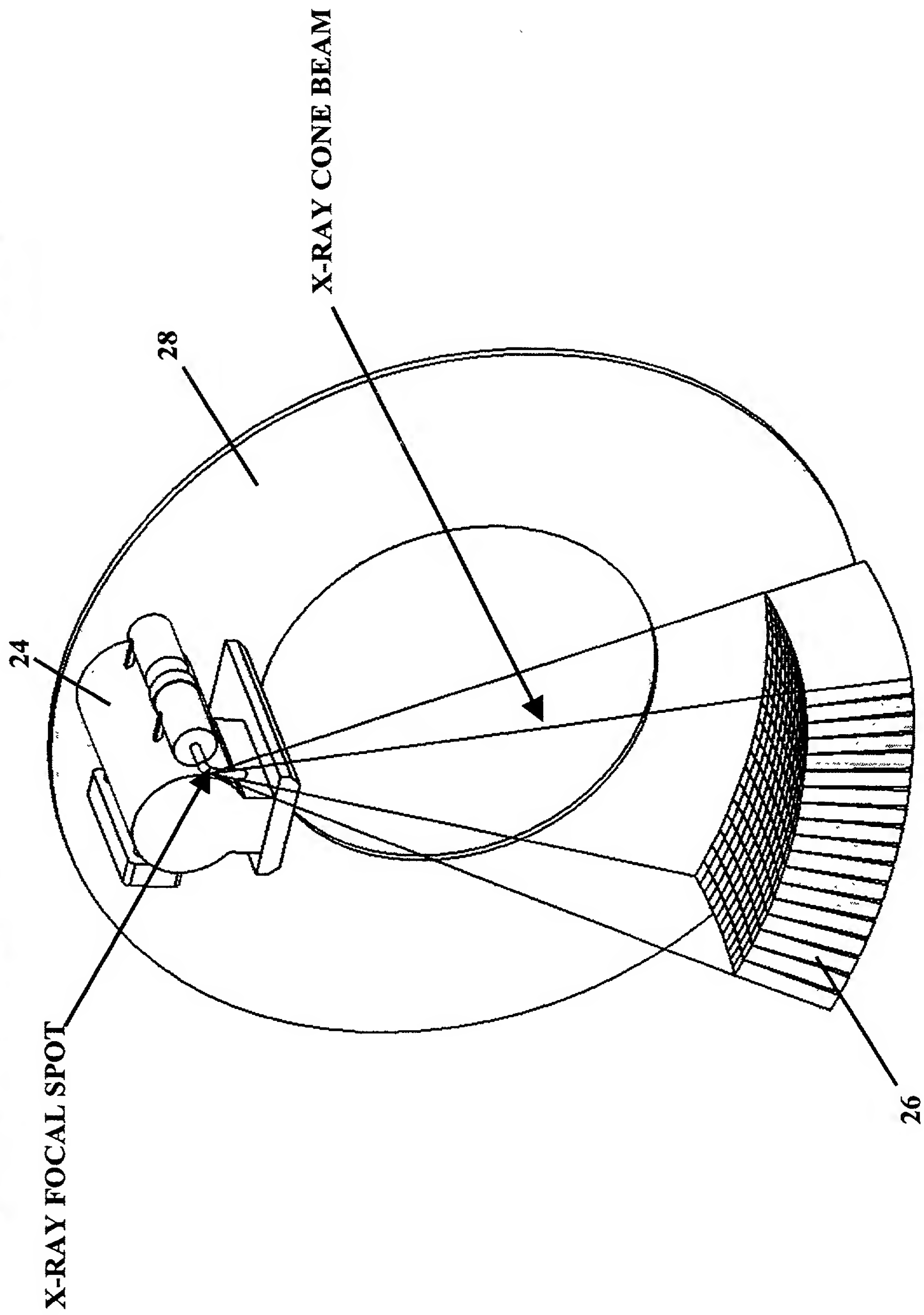
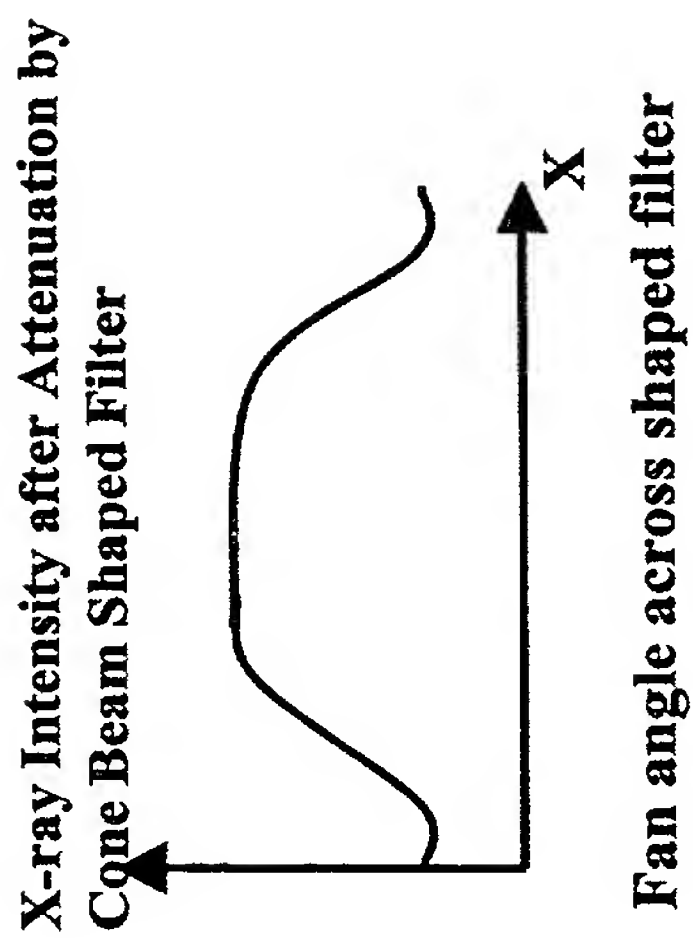
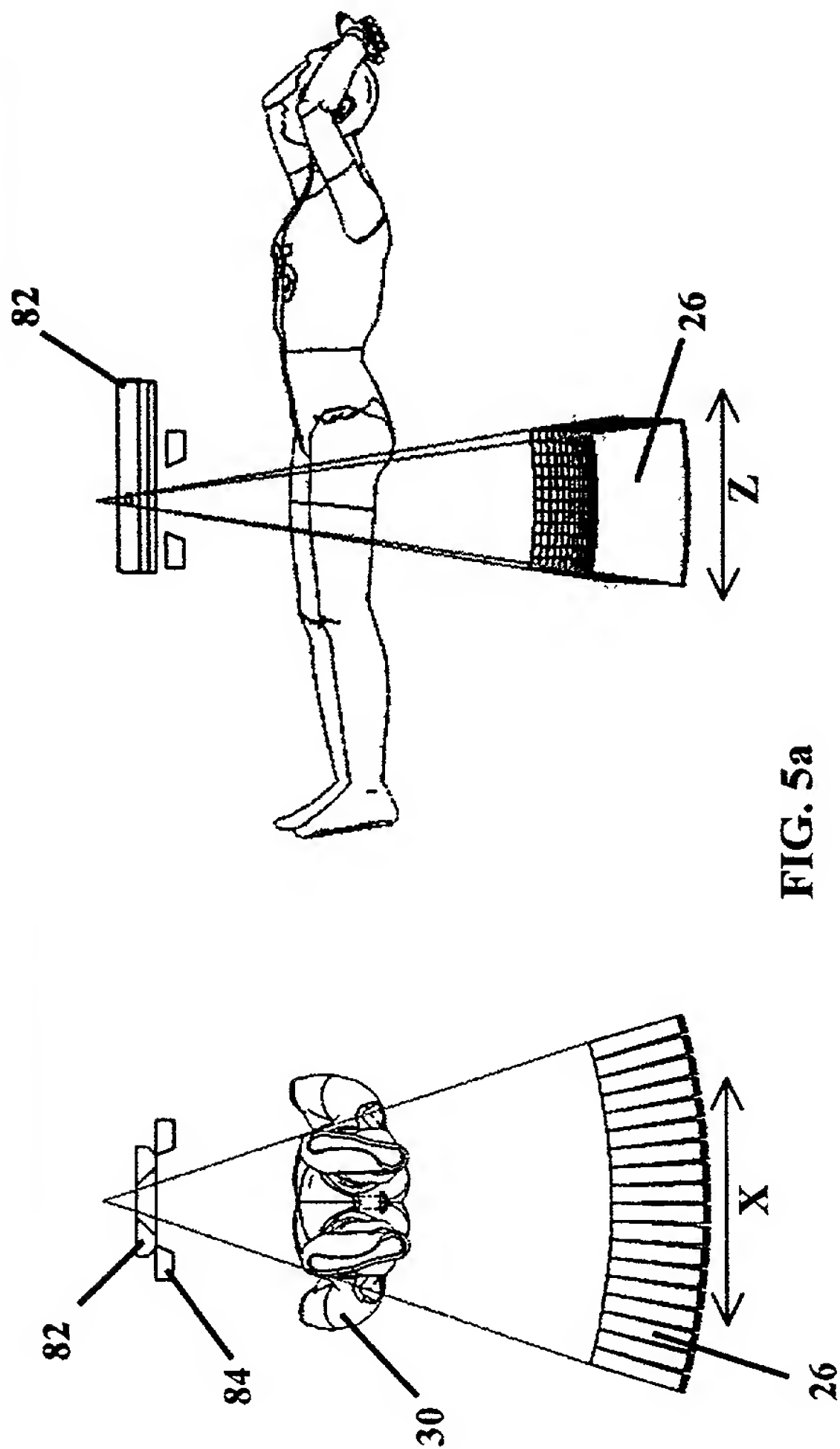


Figure 4

# Cone Beam Source Collimation & Cone Beam Shaped Filter



Intensity after Attenuation by  
Shaped Filter and Patient

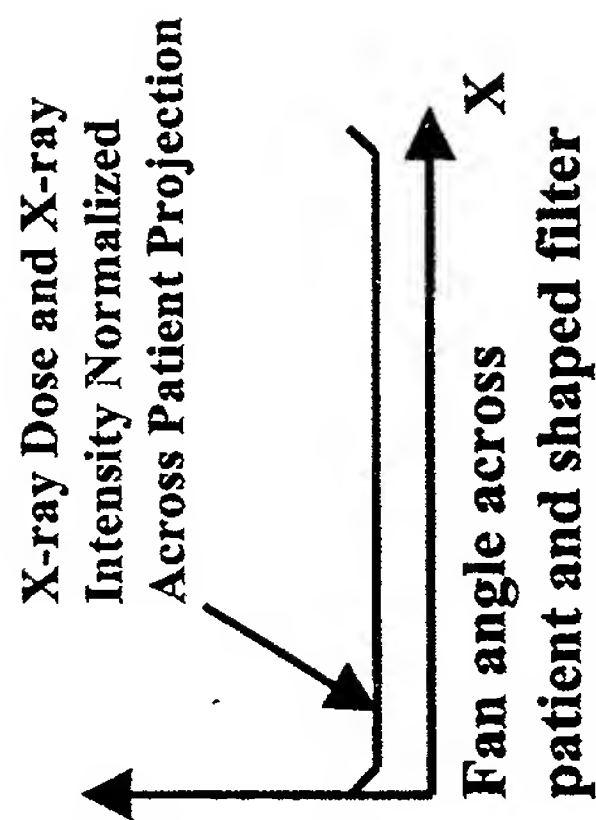
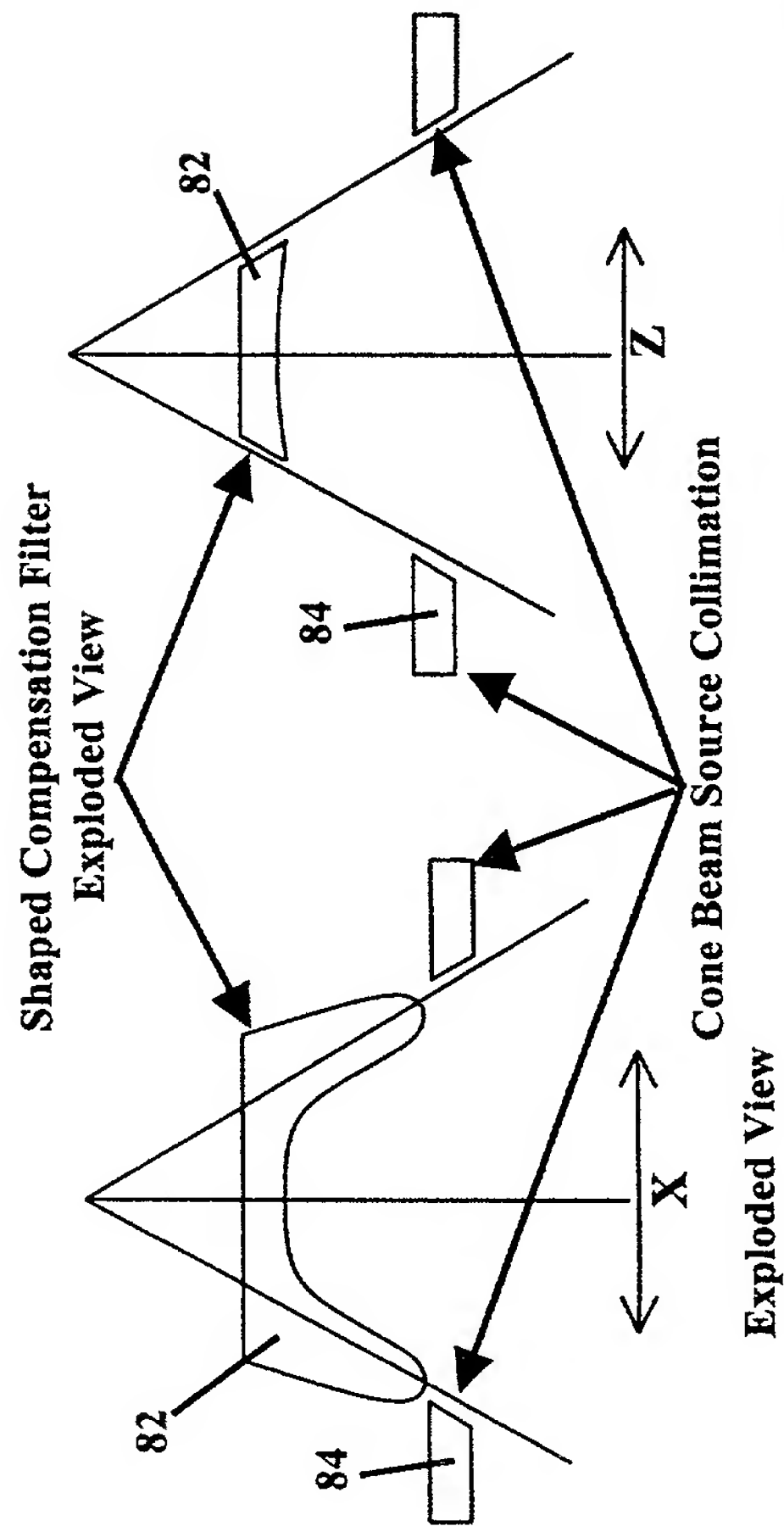


Figure 5

# X-ray Cone Beam Focal Spot - Curved Detector Optics

Curved Detector to reduce spatial resolution loss and Best Conversion efficiency of X-ray

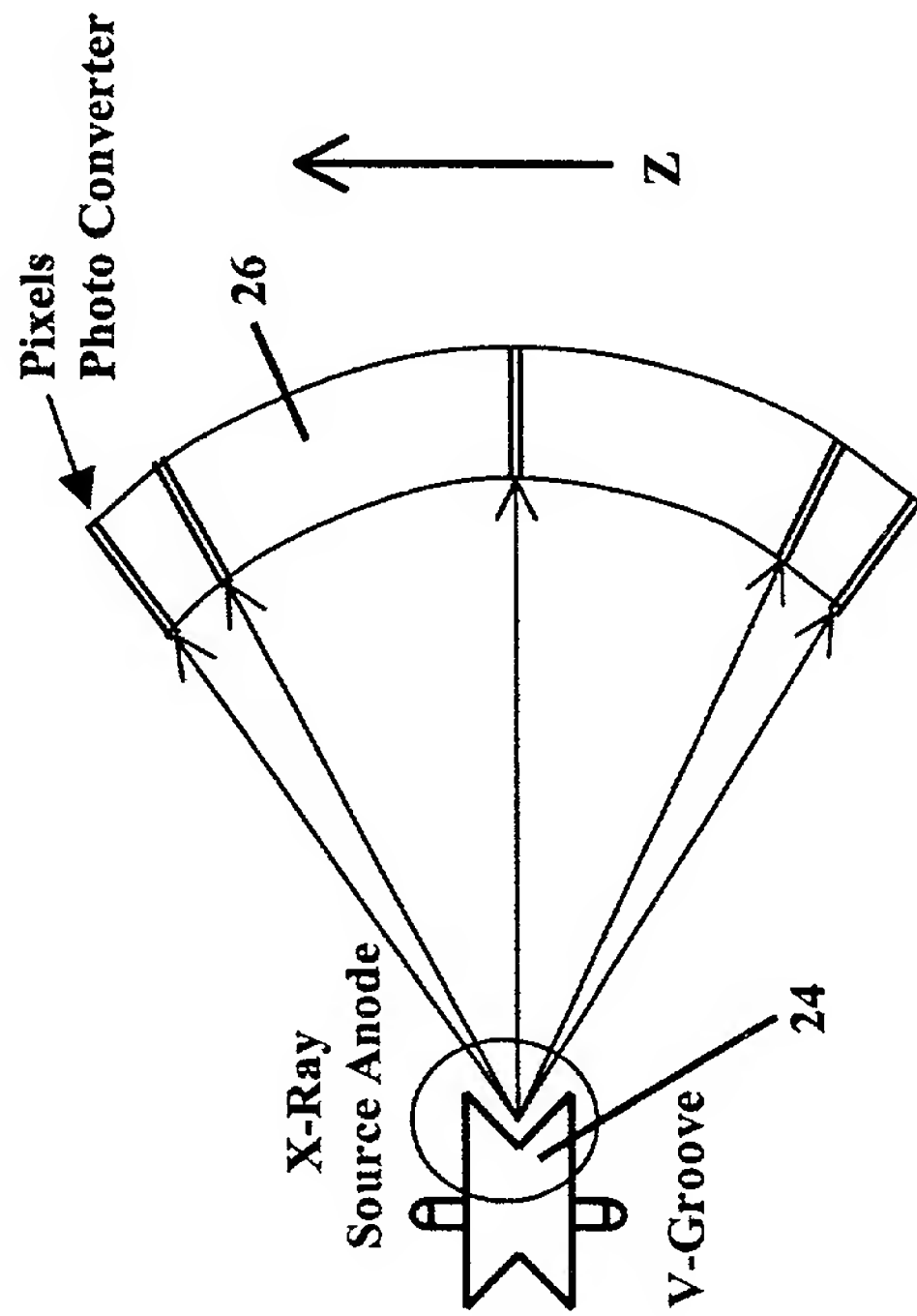
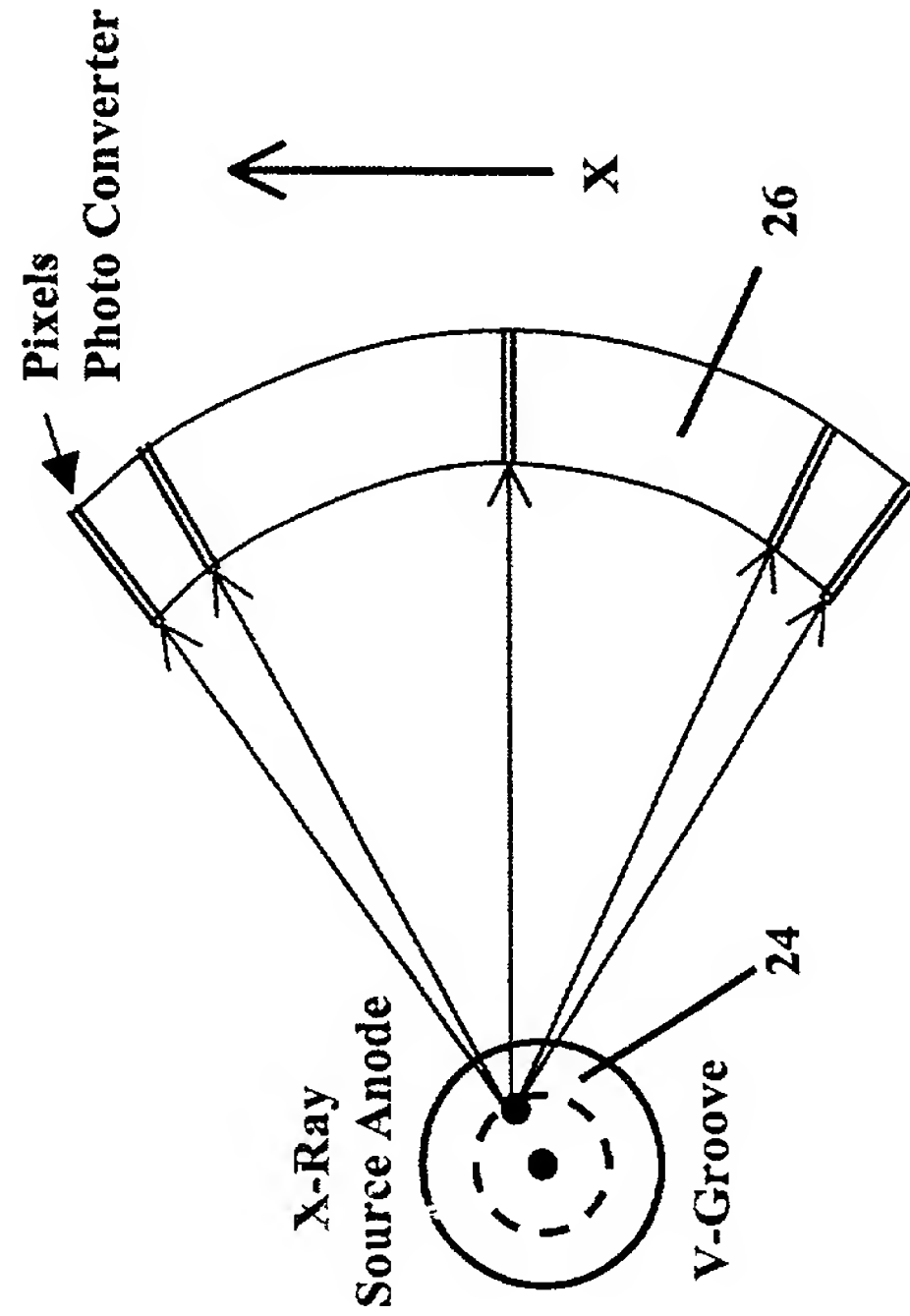


FIG. 6a



Focal spot from V-groove Type Anode has similar spot size appearance

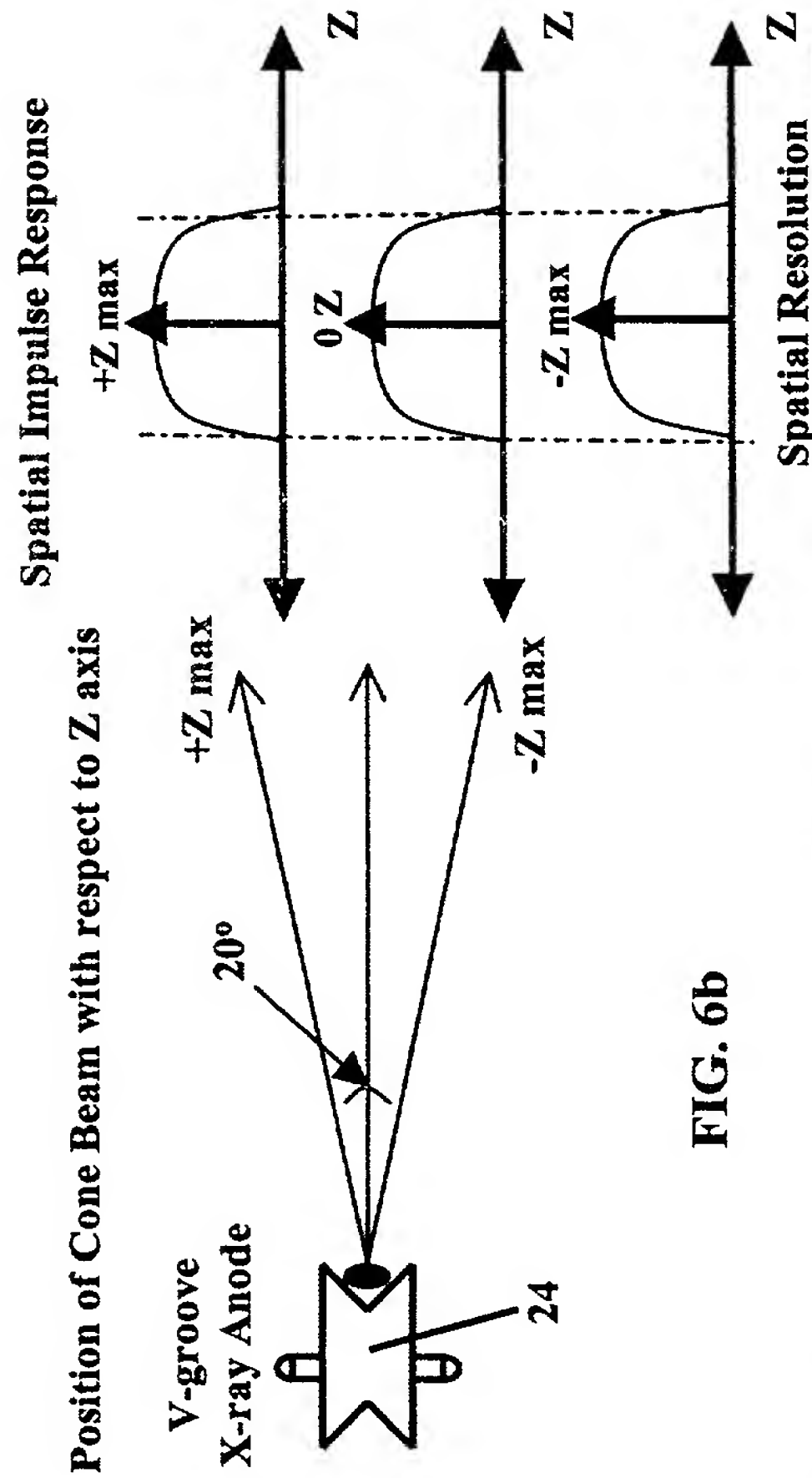


FIG. 6b

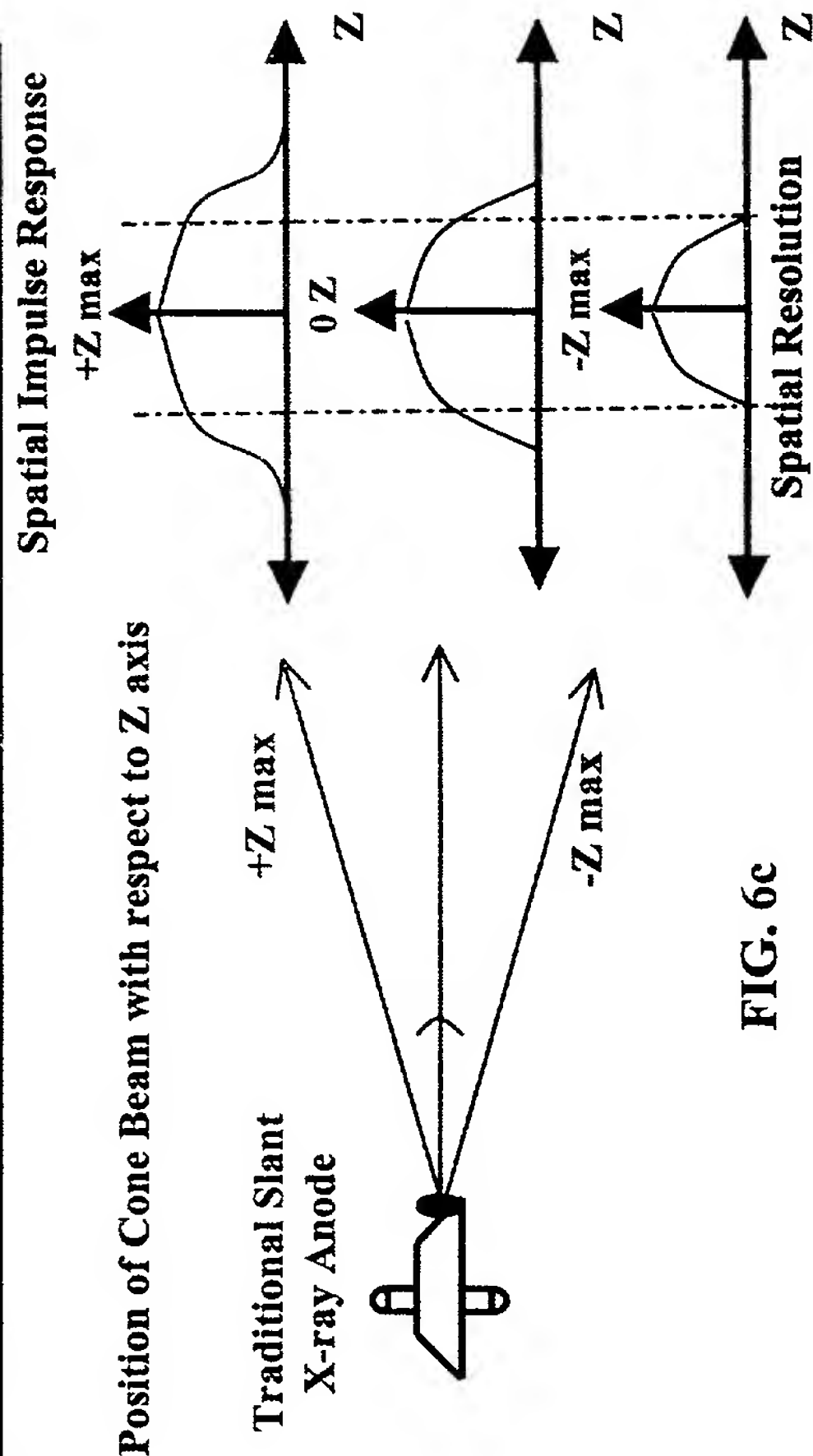


FIG. 6c

Figure 6



# 2 Dimensional Focal Spot Dithering for Improved Cone Beam

## Spatial Resolution

### X-ray Focal Spot Geometric Dithering For Doubling the Spatial Sampling Rate

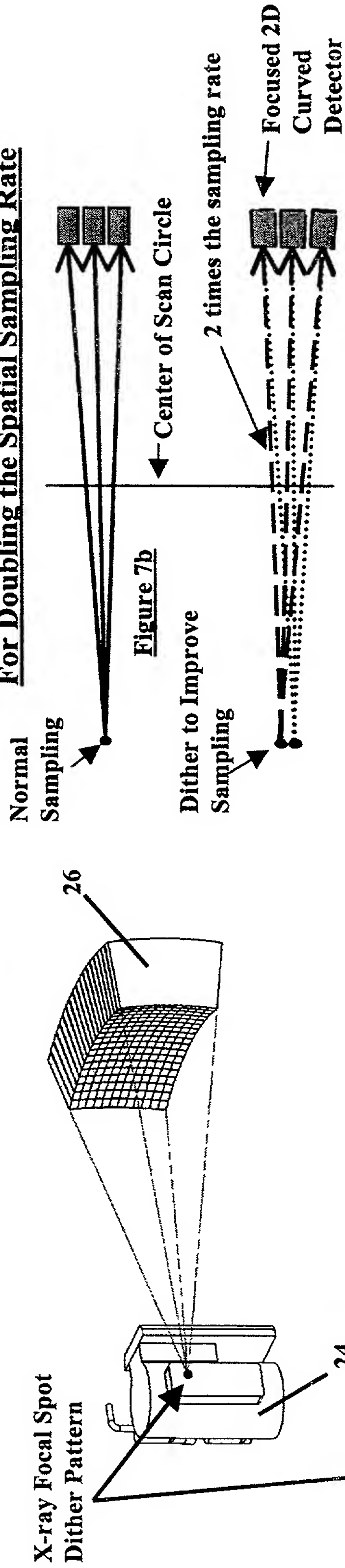
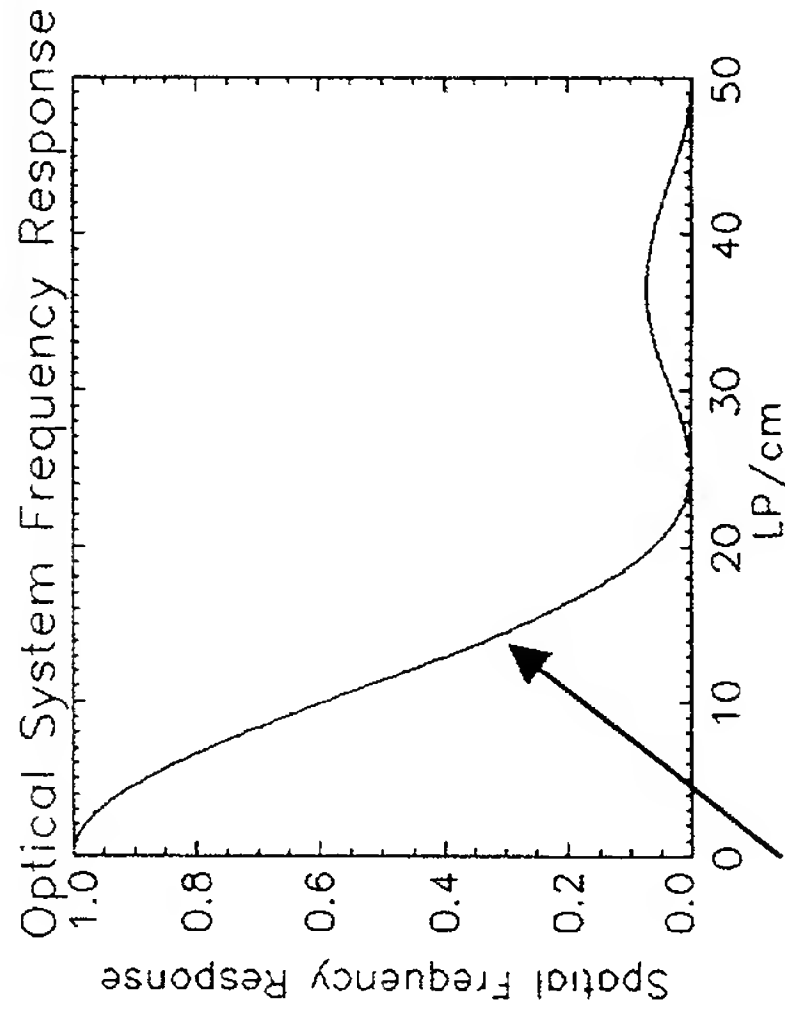


Figure 7a

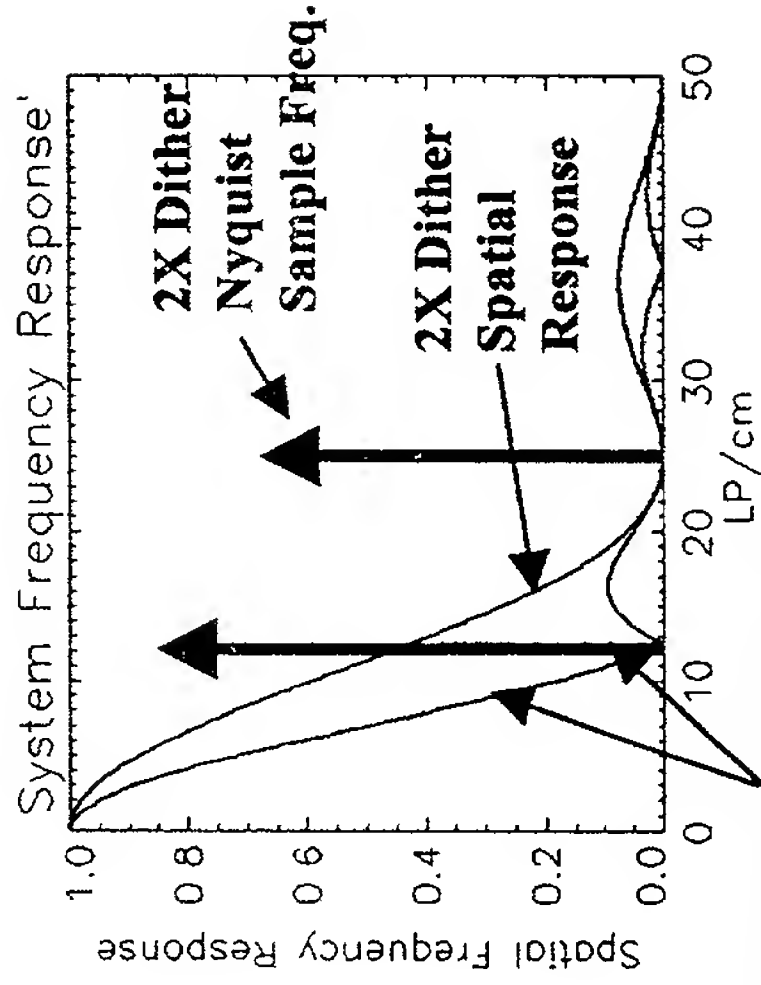
Figure 7c

### Spatial Resolution comparison between Single Sampling and 2X Dither Sampling



X-ray Optical  
System Response  
before Sampling

Figure 7e



Normal Nyquist Sample  
Freq. & aliased optical  
response

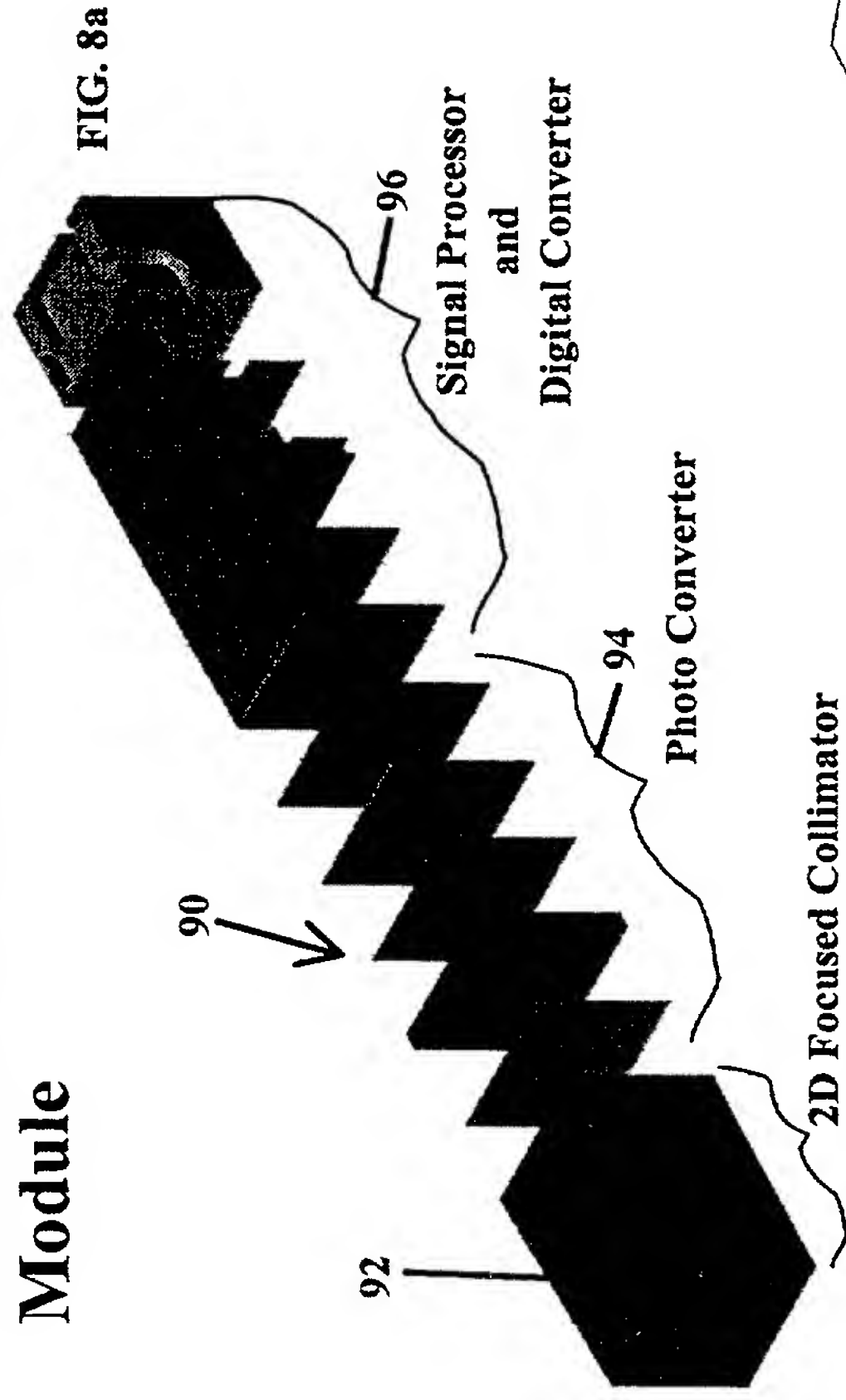
Figure 7f

Figure 7

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# Focused 2D Curved Detector Module

## Focused Curved Detector Module



## View Showing Focused 2D Anti-scatter Collimation with 2D Focused Pixels

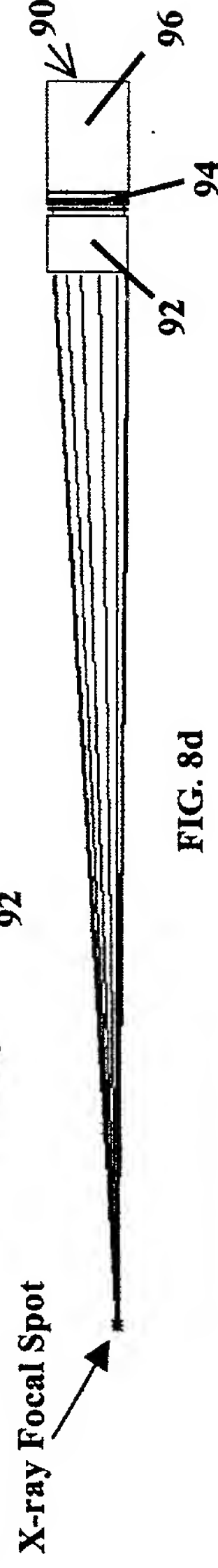
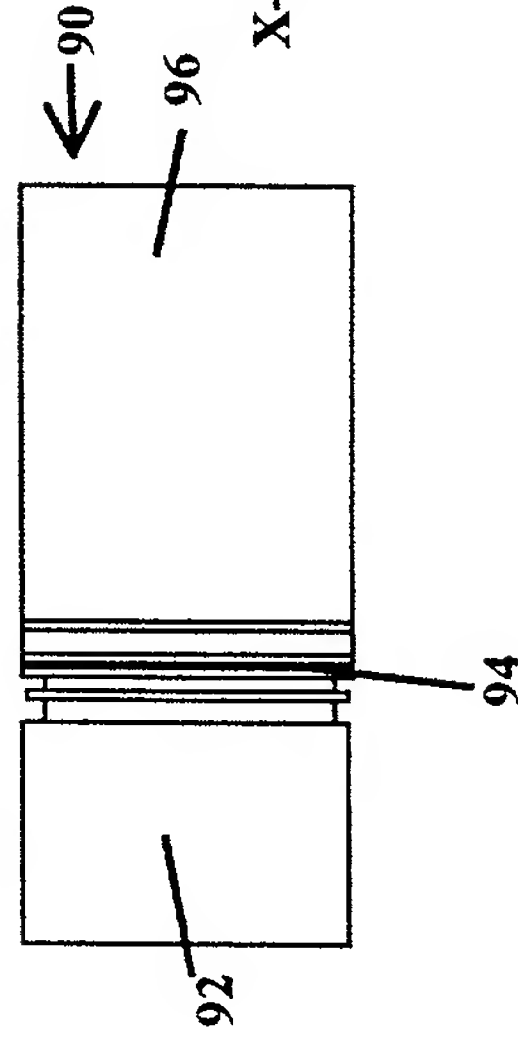
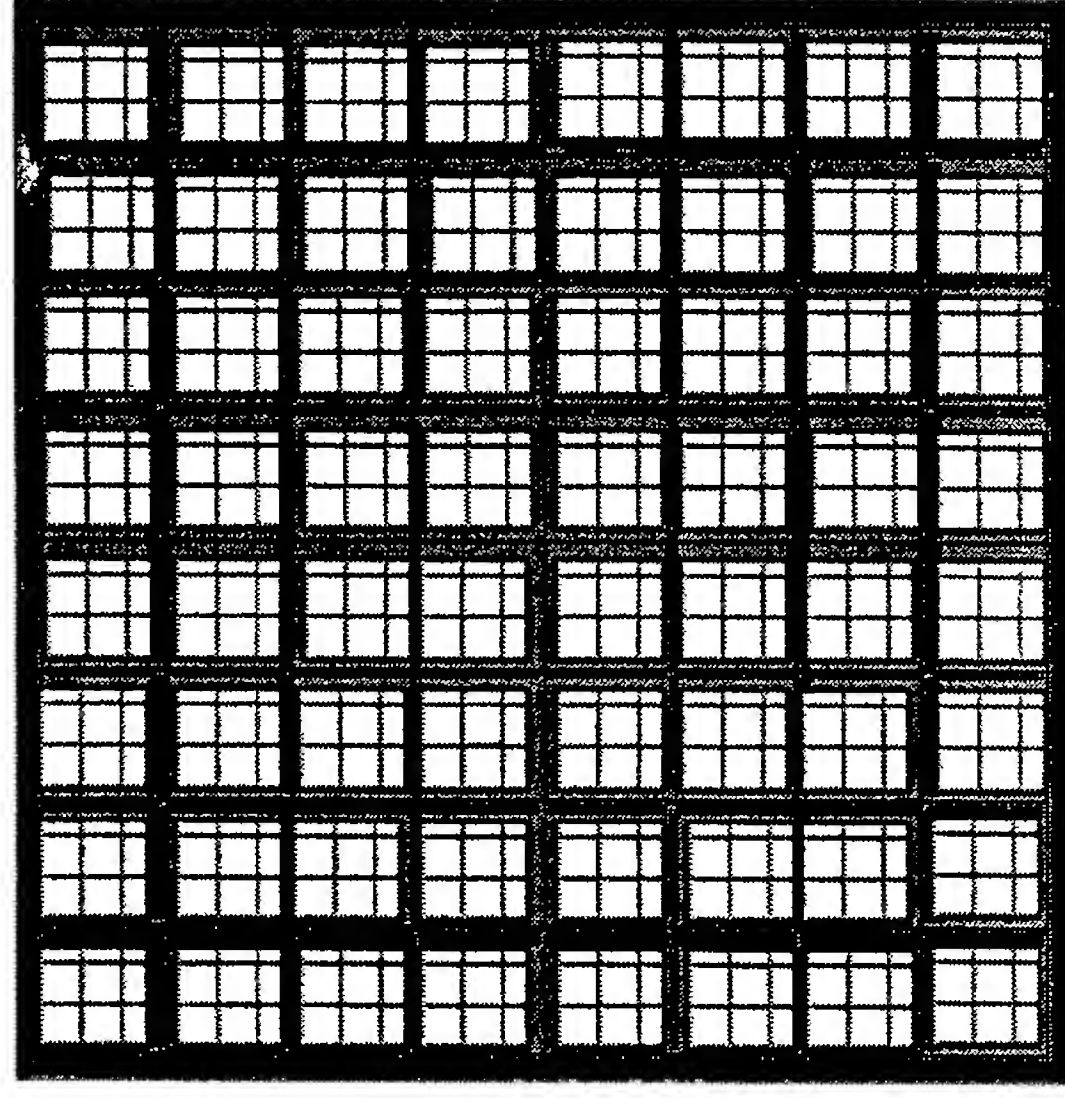


FIG. 8b

Figure 8

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# Focused 2D Area Detector with Adaptive Shaped X-Ray Optical Response

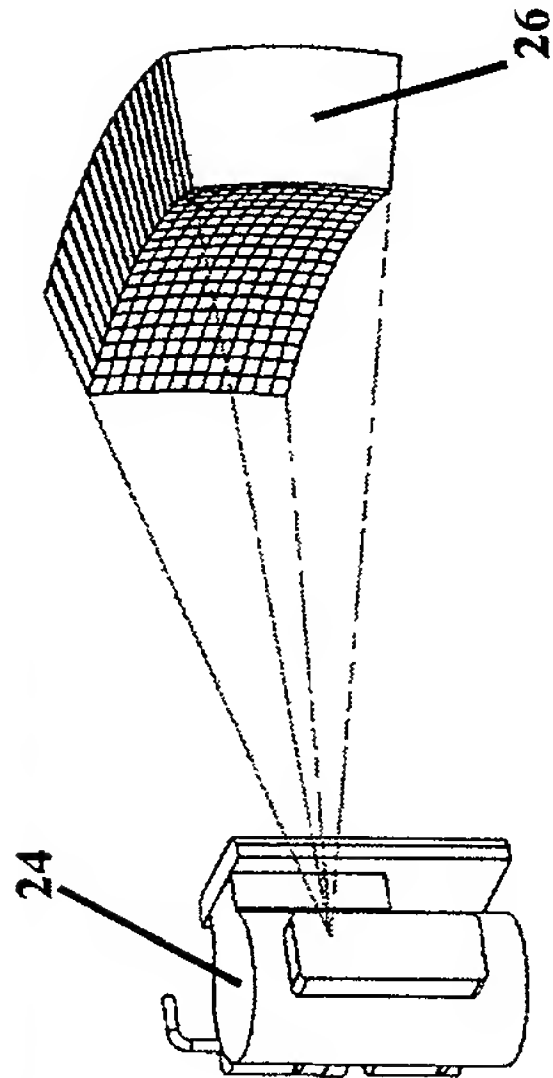
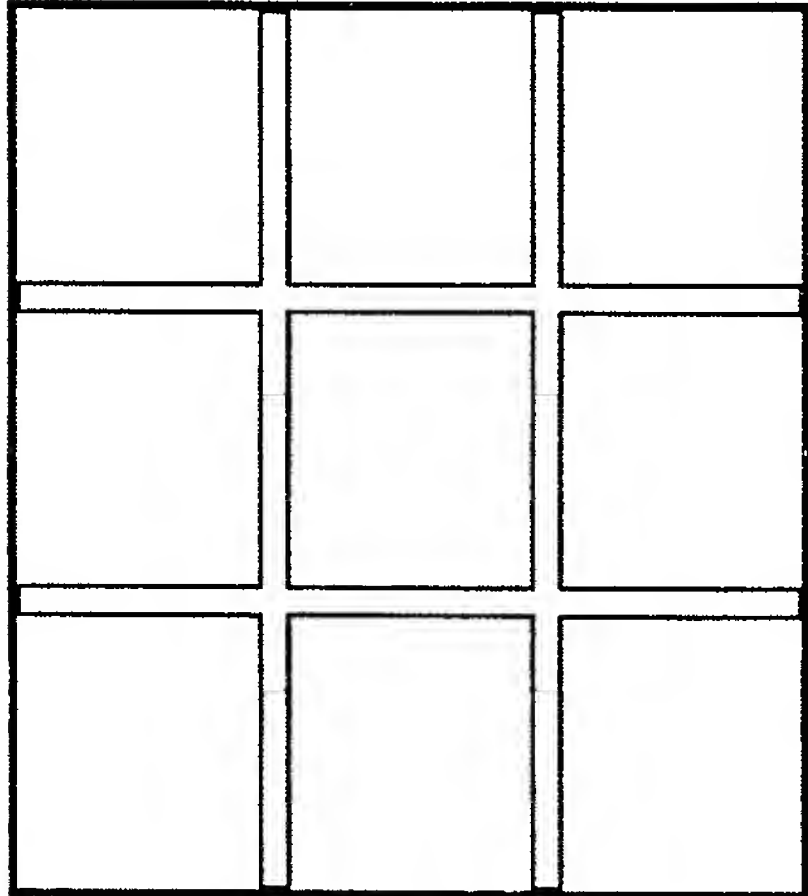
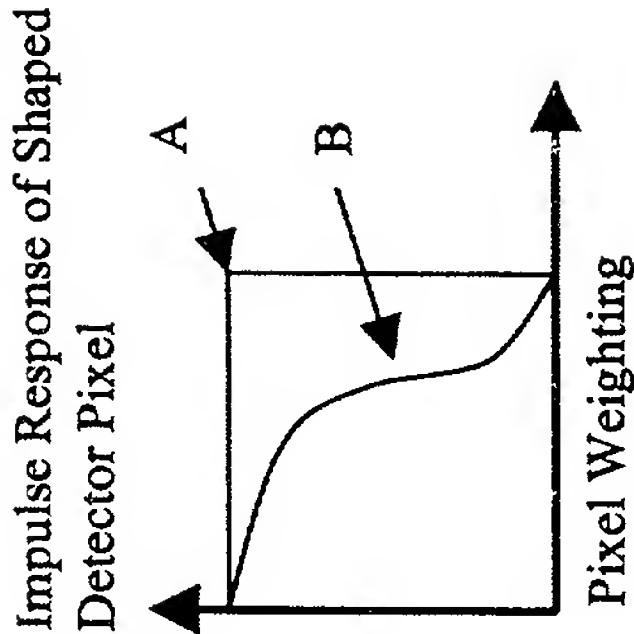


FIG. 9a

Impulse Response Shaping from Rectangular to Variable gaussian Roll-off Function. Shaping may be Fixed or Controlled



Detector Pixel  
FIG. 9b



1	1	1
1	1	1
1	1	1

A

.2	.44	.2
.44	1	.44
.2	.44	.2

B

FIG. 9f

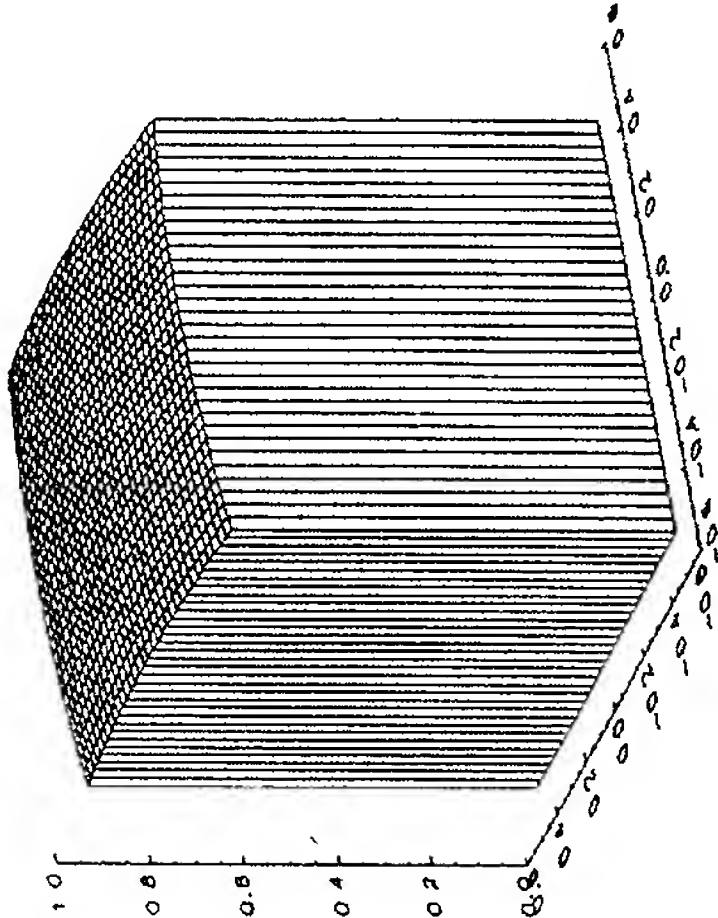


FIG. 9c

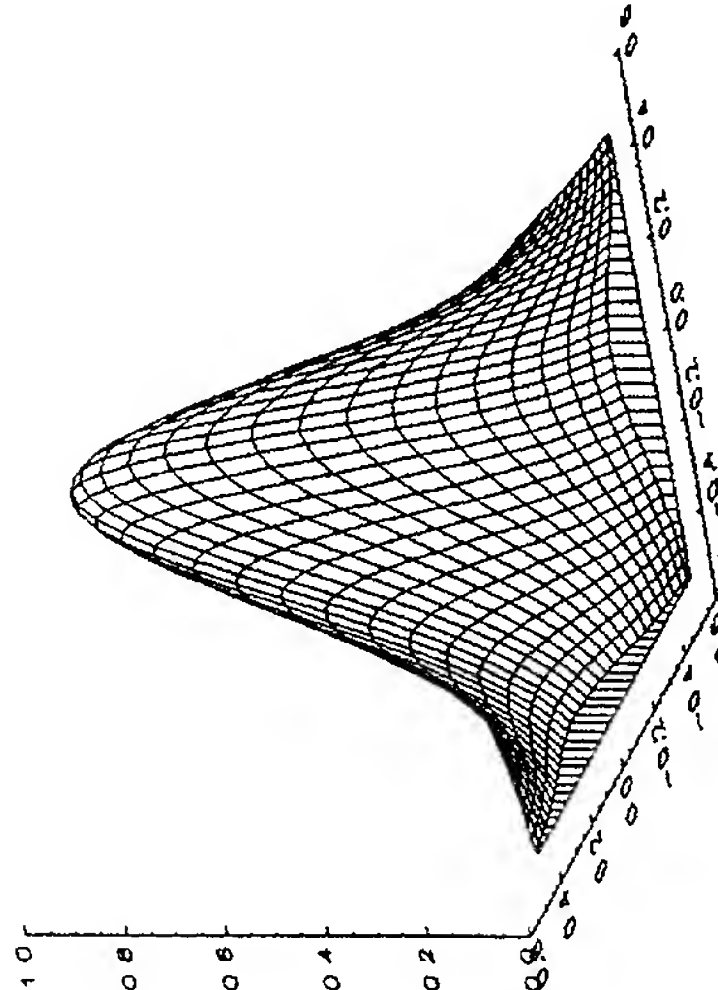


FIG. 9d

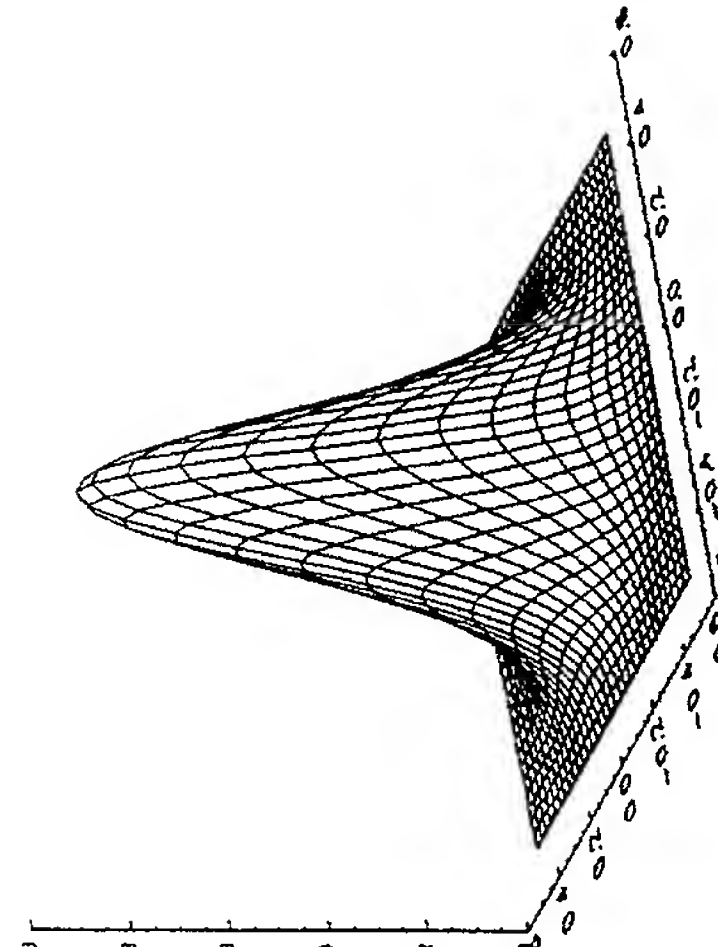


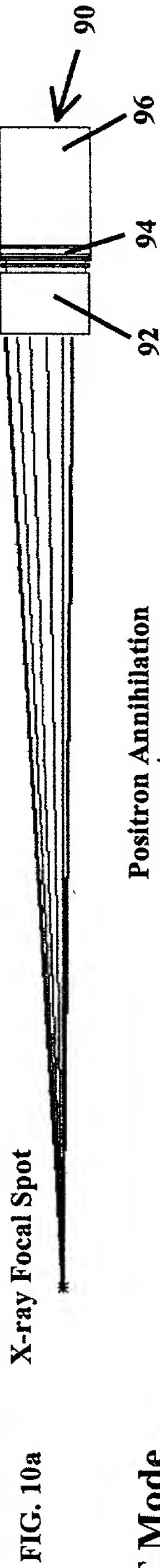
FIG. 9e

Figure 9

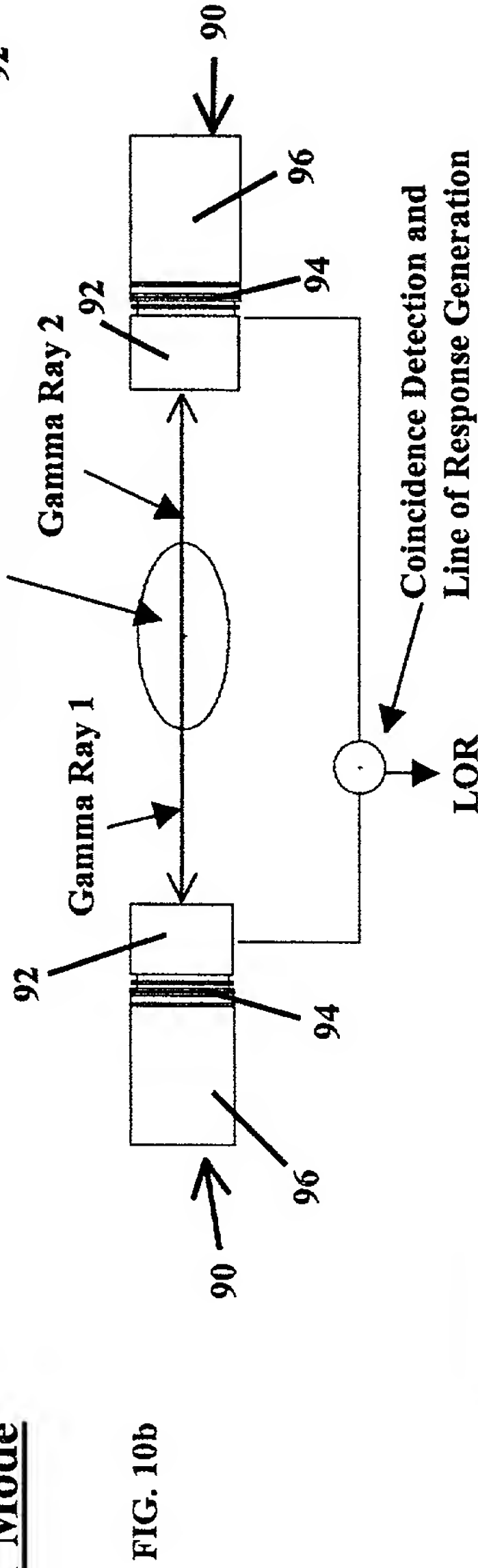
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# Multi-Modality XGA Detector Module

## X-Ray Mode



## PET Mode



## NM/SPECT Mode

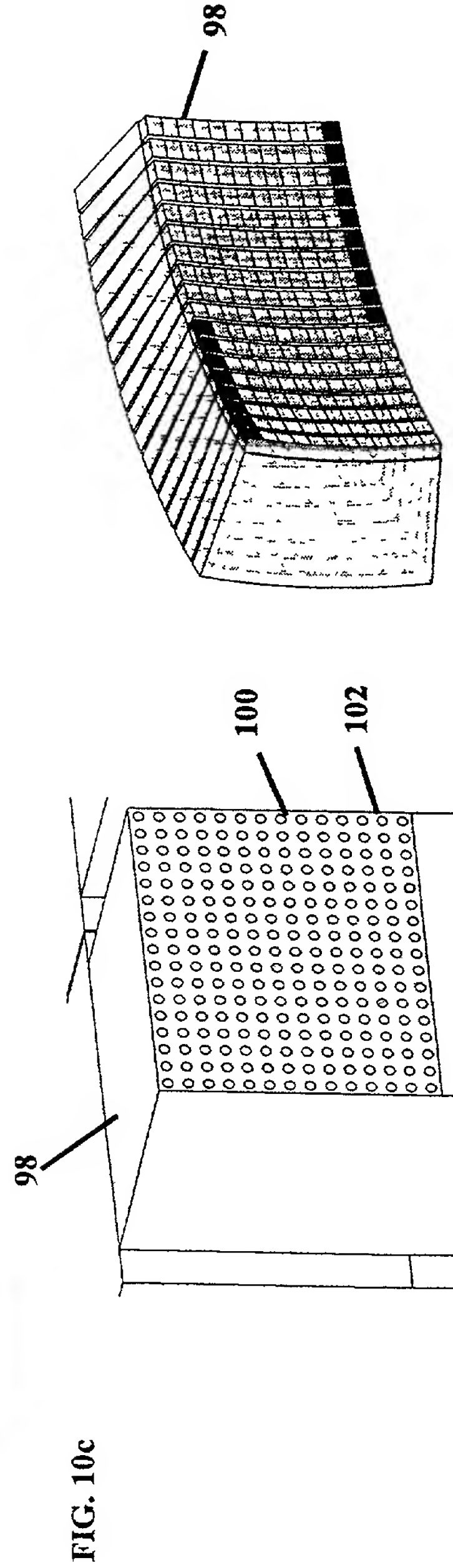


Figure 10

# Detector Module Multi-Modality Collimation

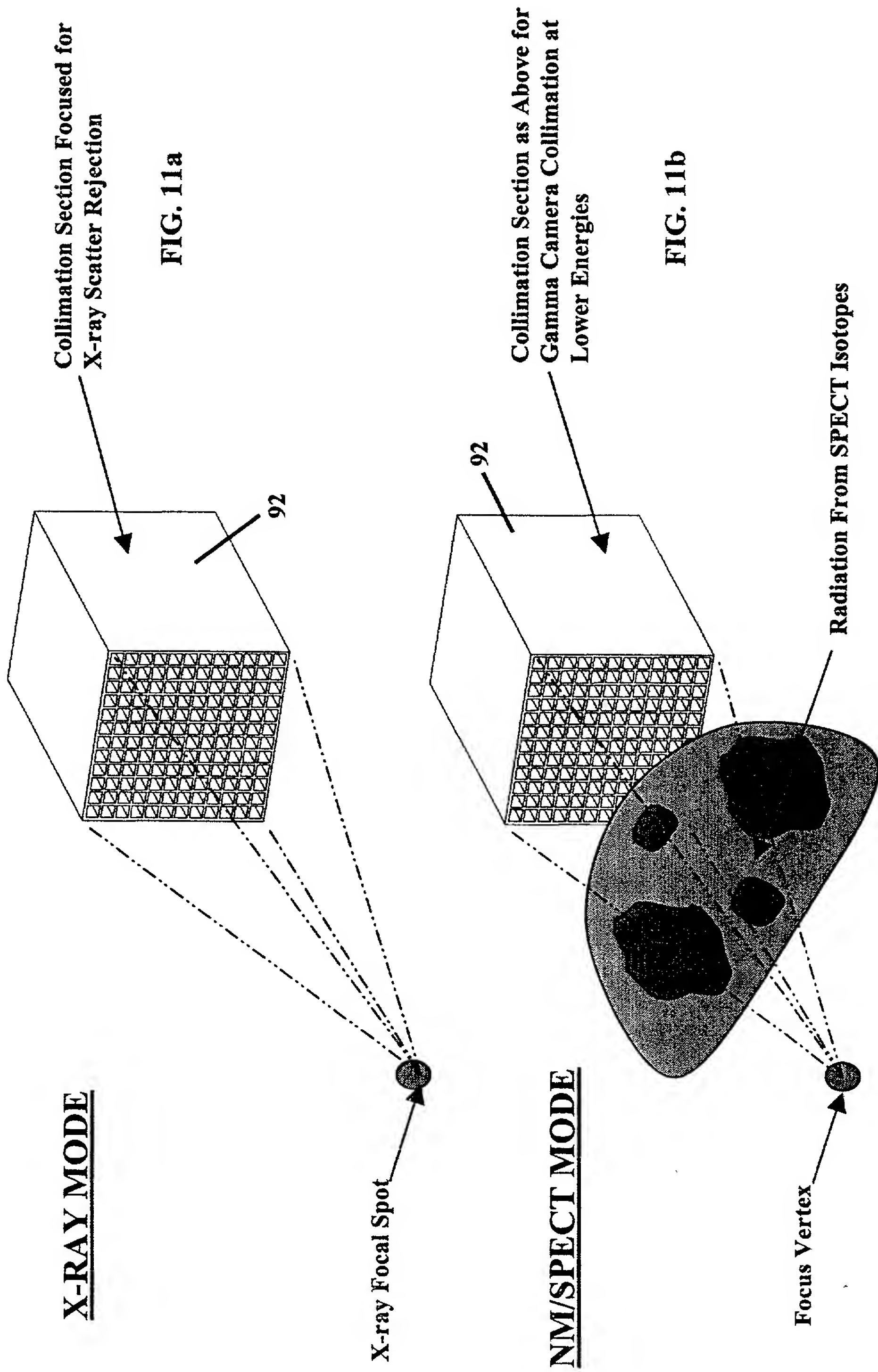


Figure 11

# XGA Detector Module Signal Processing

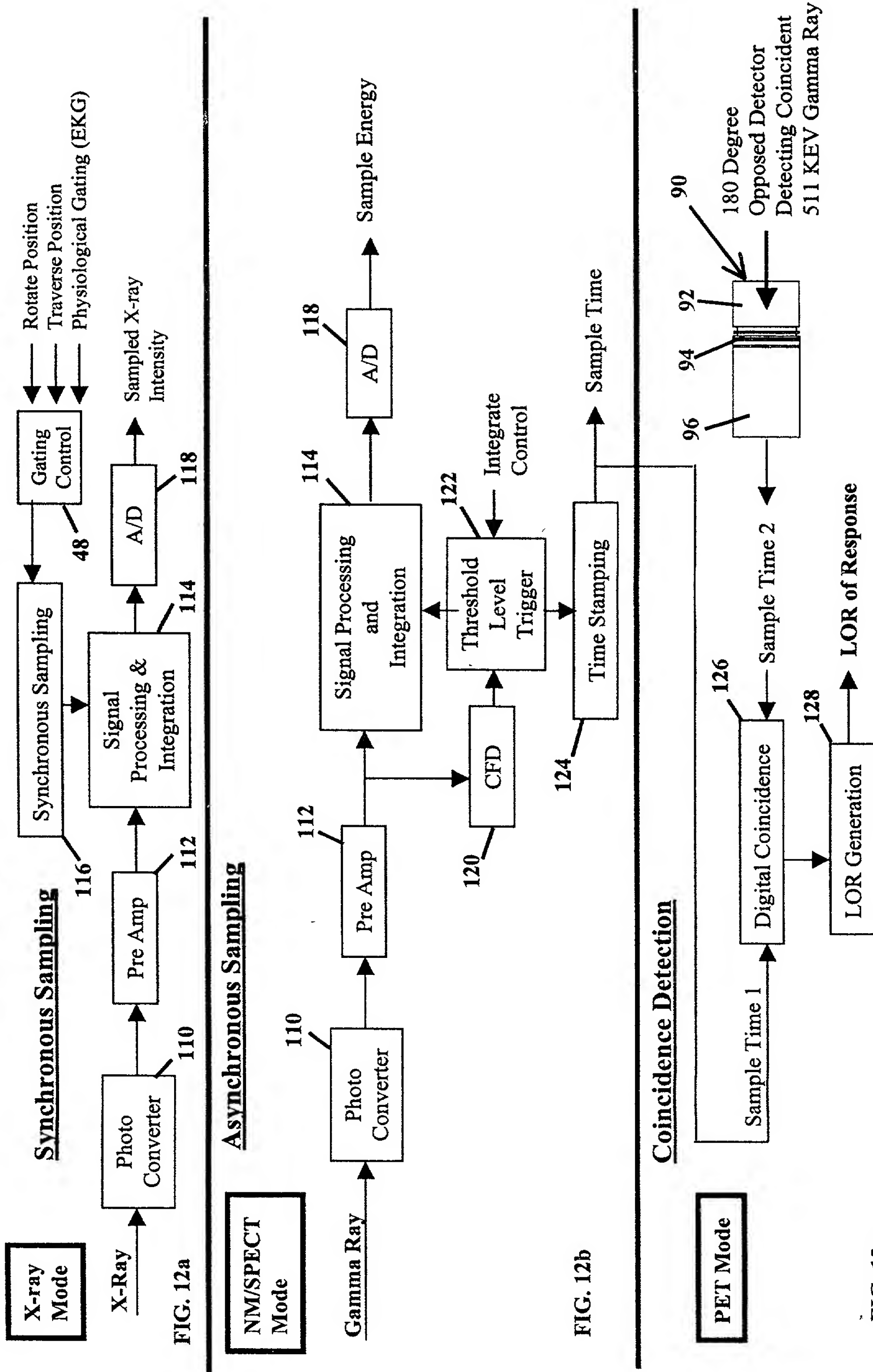
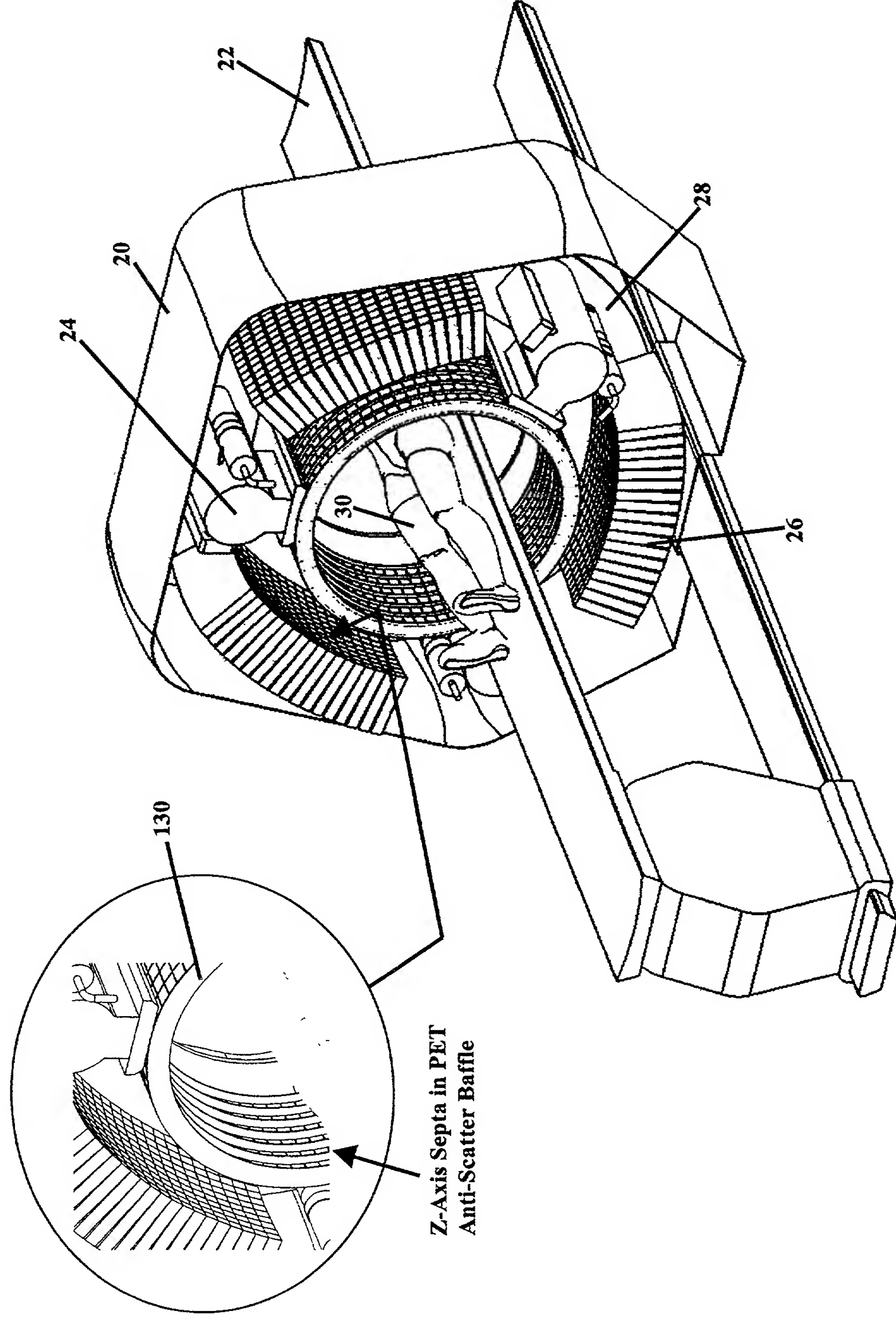


Figure 12

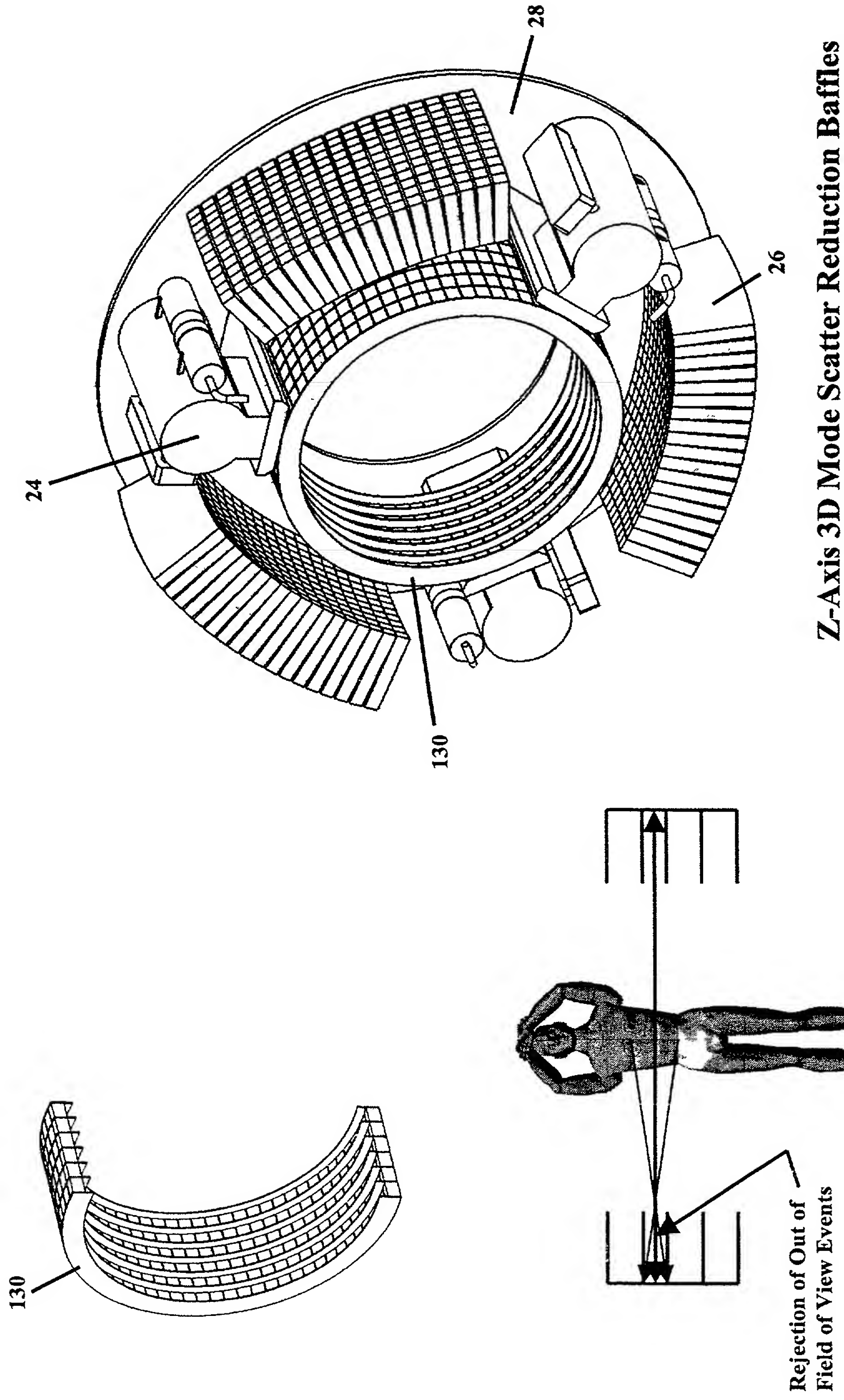
## **System with Optional PET Anti-Scatter Baffle**



## Figure 13

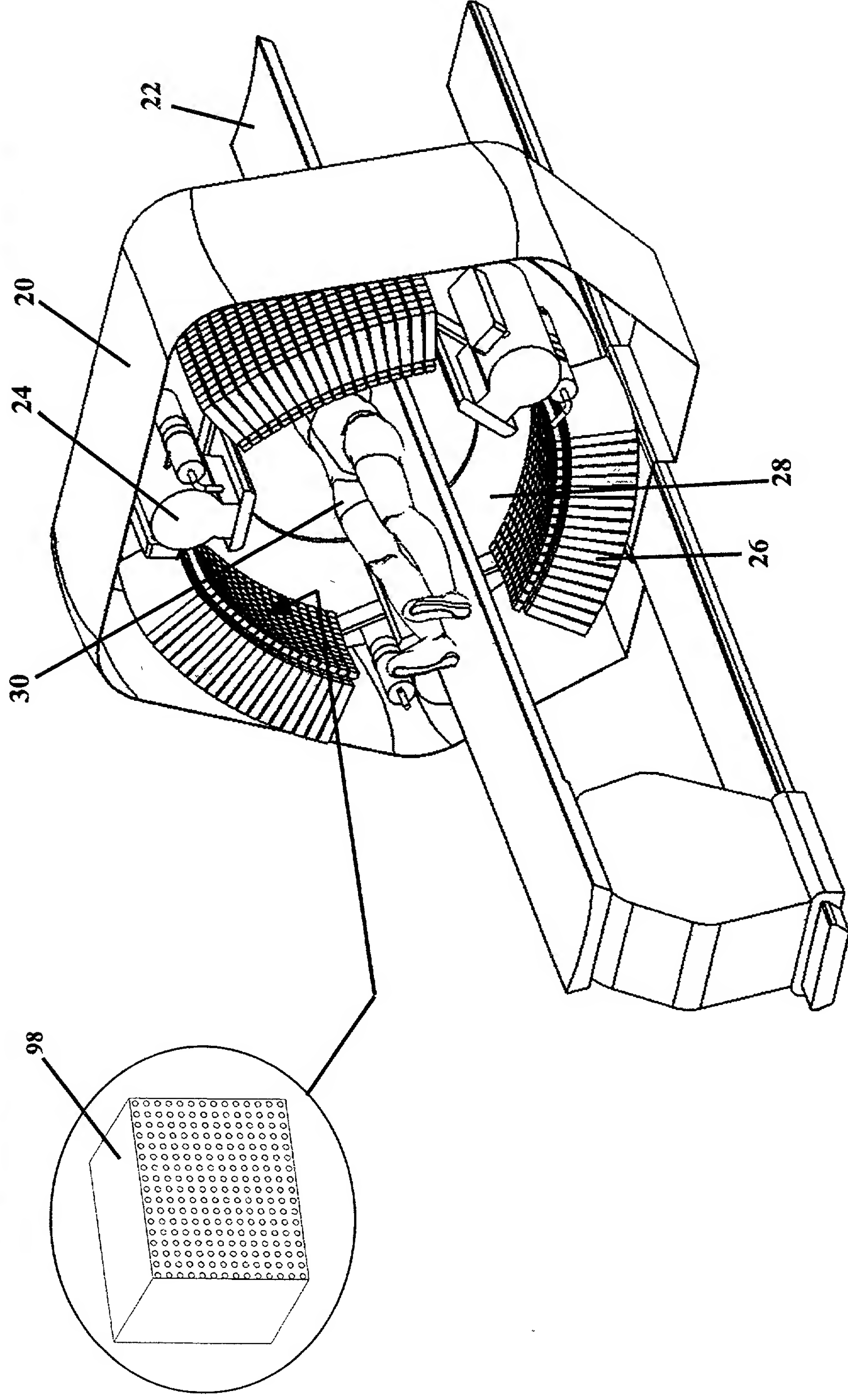


# **PET – Anti-Scatter Baffle SEPTA**



**Figure 14**

**System With Cone Beam Focused NM/SPECT Collimation**



**Figure 15**

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# NM/SPECT Mode with Collimation Ring

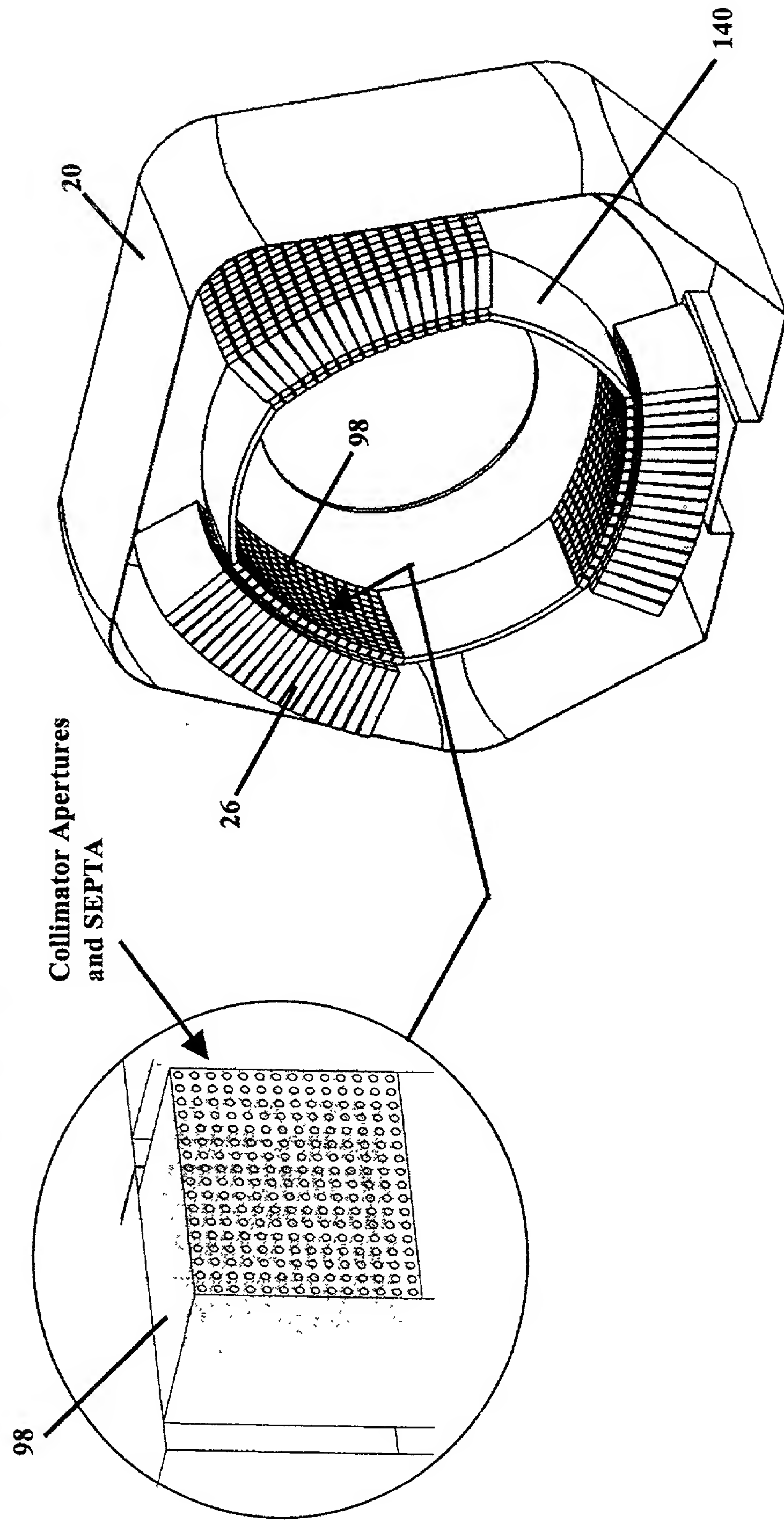


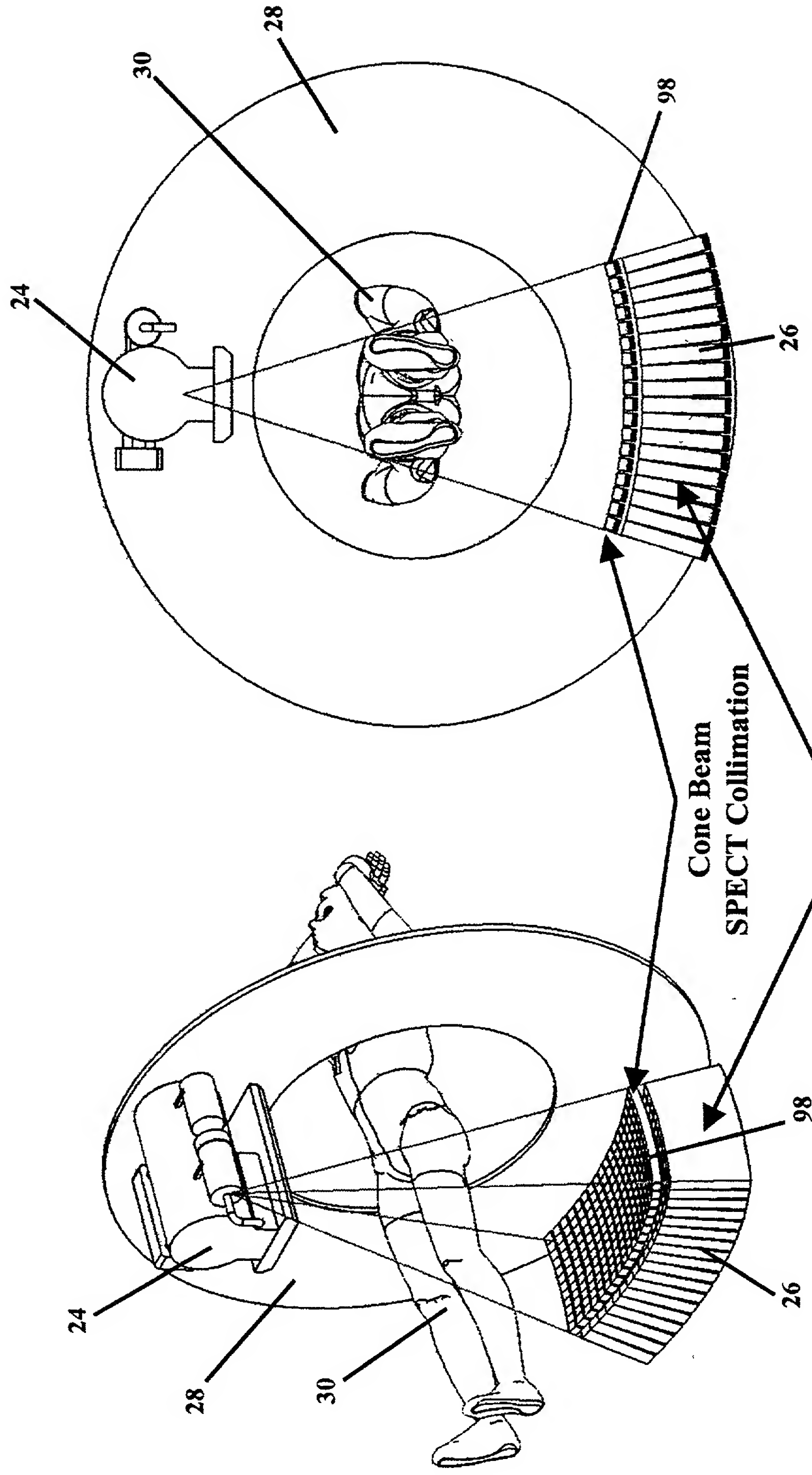
Figure 16

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# Cone Beam NM/SPECT LEHR Collimation and Focused 2D Curved

## Detector Array



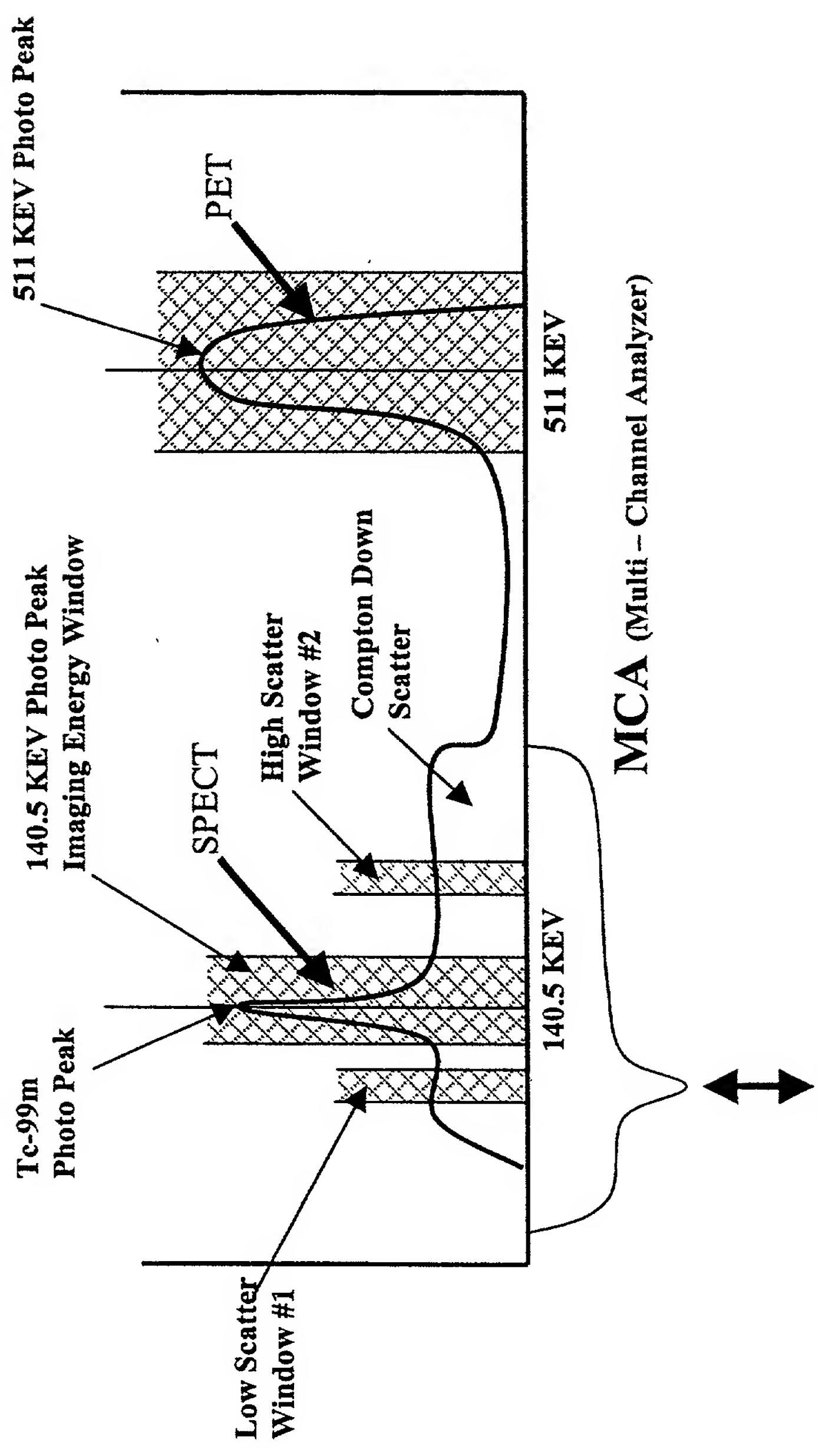
X-ray Gamma Ray Area Detector. [XGA] Detector Which is Focused at Point Where X-ray Focal Spot is.

**Figure 17**

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# Multi-Isotope Scanning



- Scatter Correction and 511 KEV Photo Peak Suppression for SPECT Imaging
- NM/SPECT Detector Must Function with 511 KEV Isotope Present for Multi-Isotope Imaging

**Figure 18**

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# X-Ray Detector Scatter Rejection with Focused 2D Curved Collimation

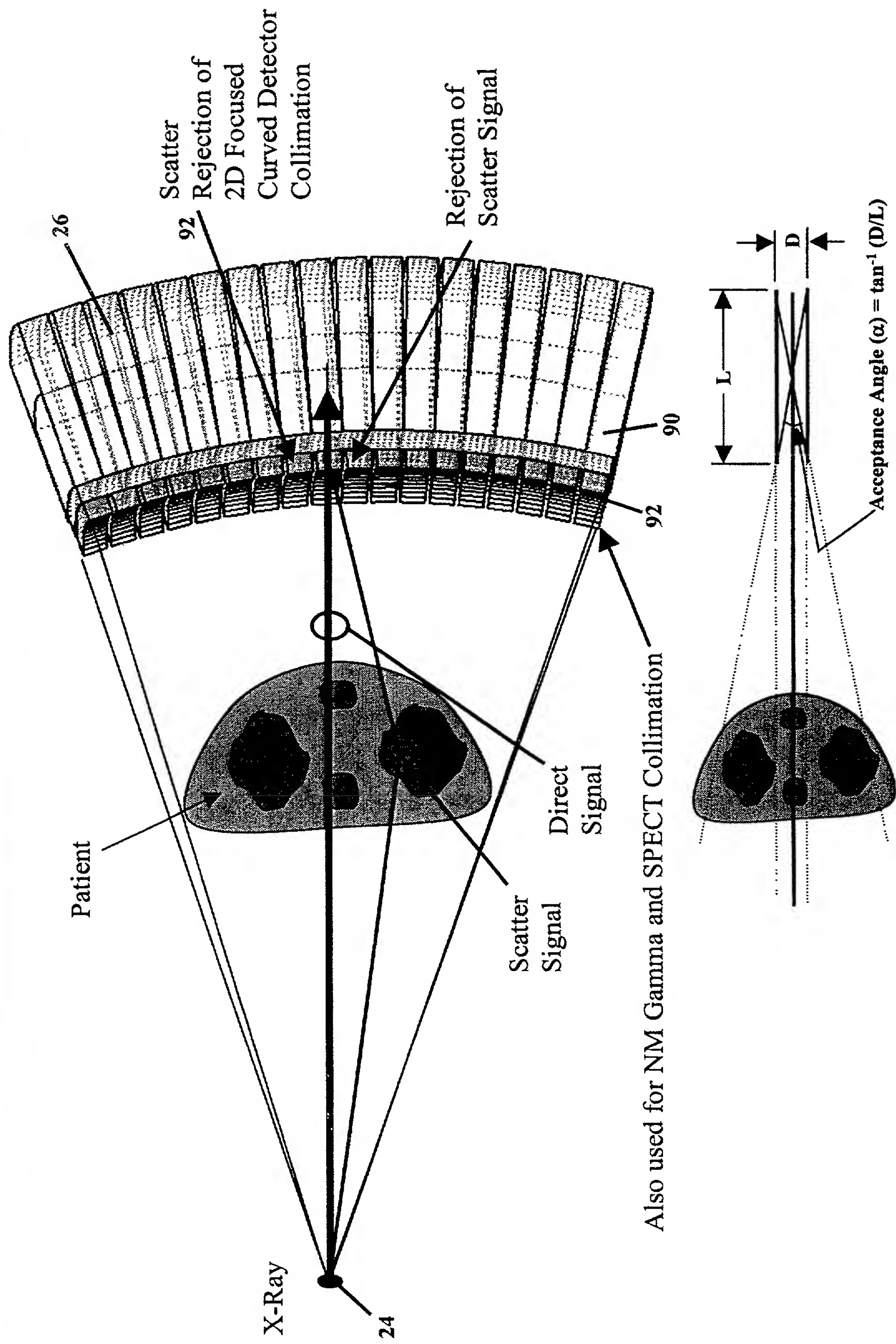


Figure 19

Also used for NM Gamma and SPECT Collimation

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# Sequencing of X-ray Sources for Adaptive Scatter Correction

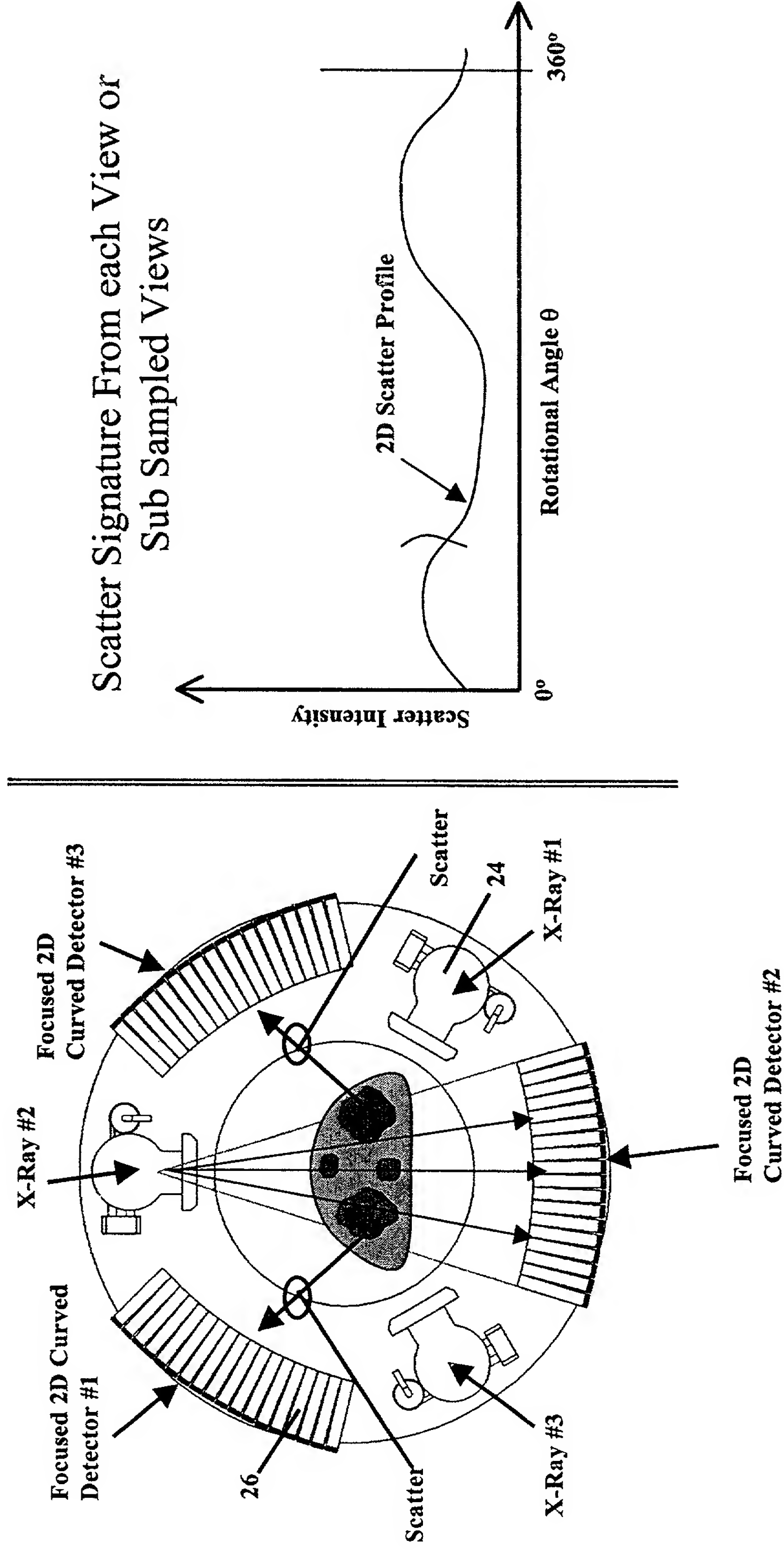


Figure 20

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# Modulation and Demodulation for Scatter Correction with Multiple Sources

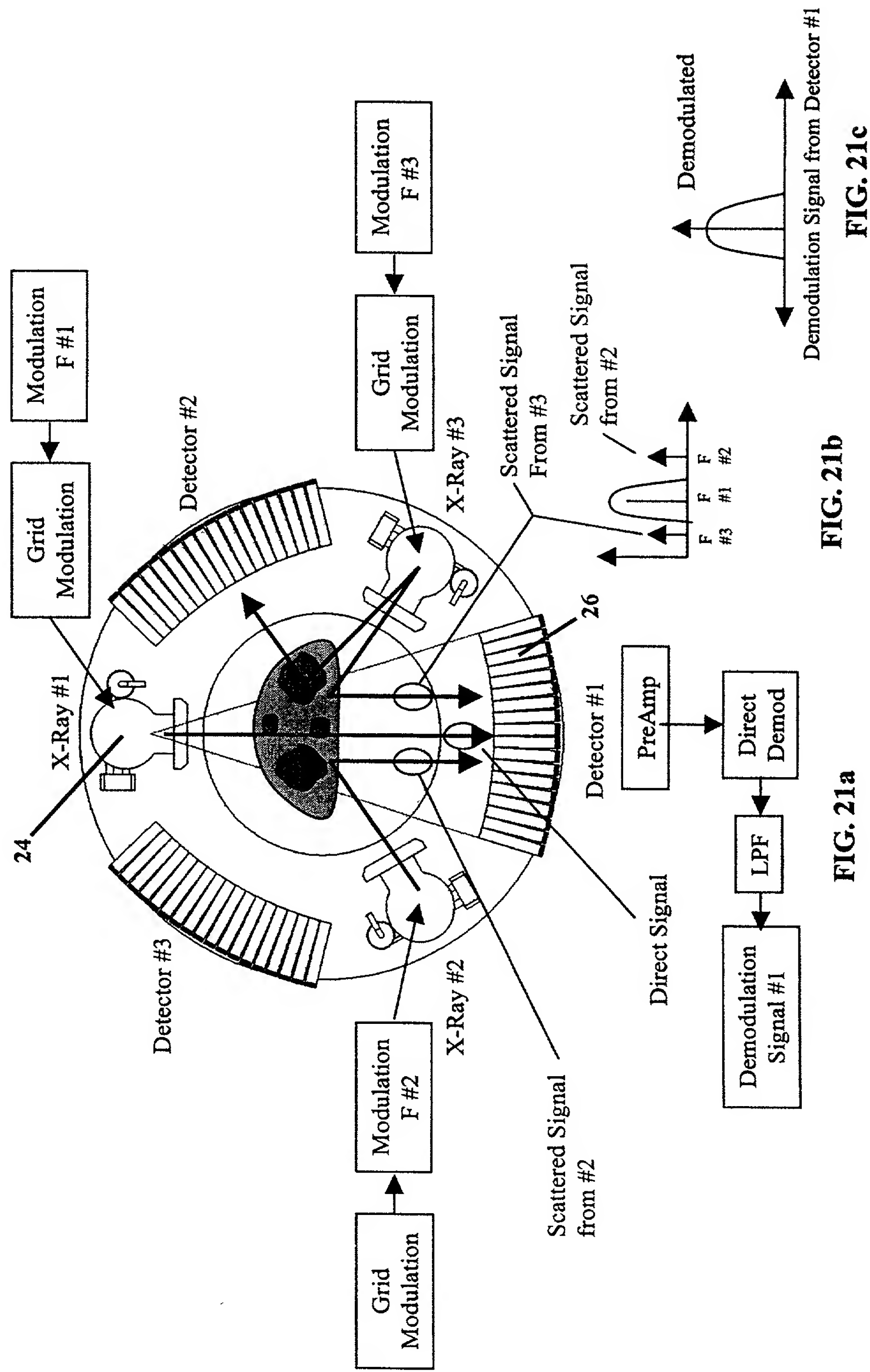


Figure 21

# System Level Diagram of Modulation and Demodulation For Multiple

## Sources for VCT

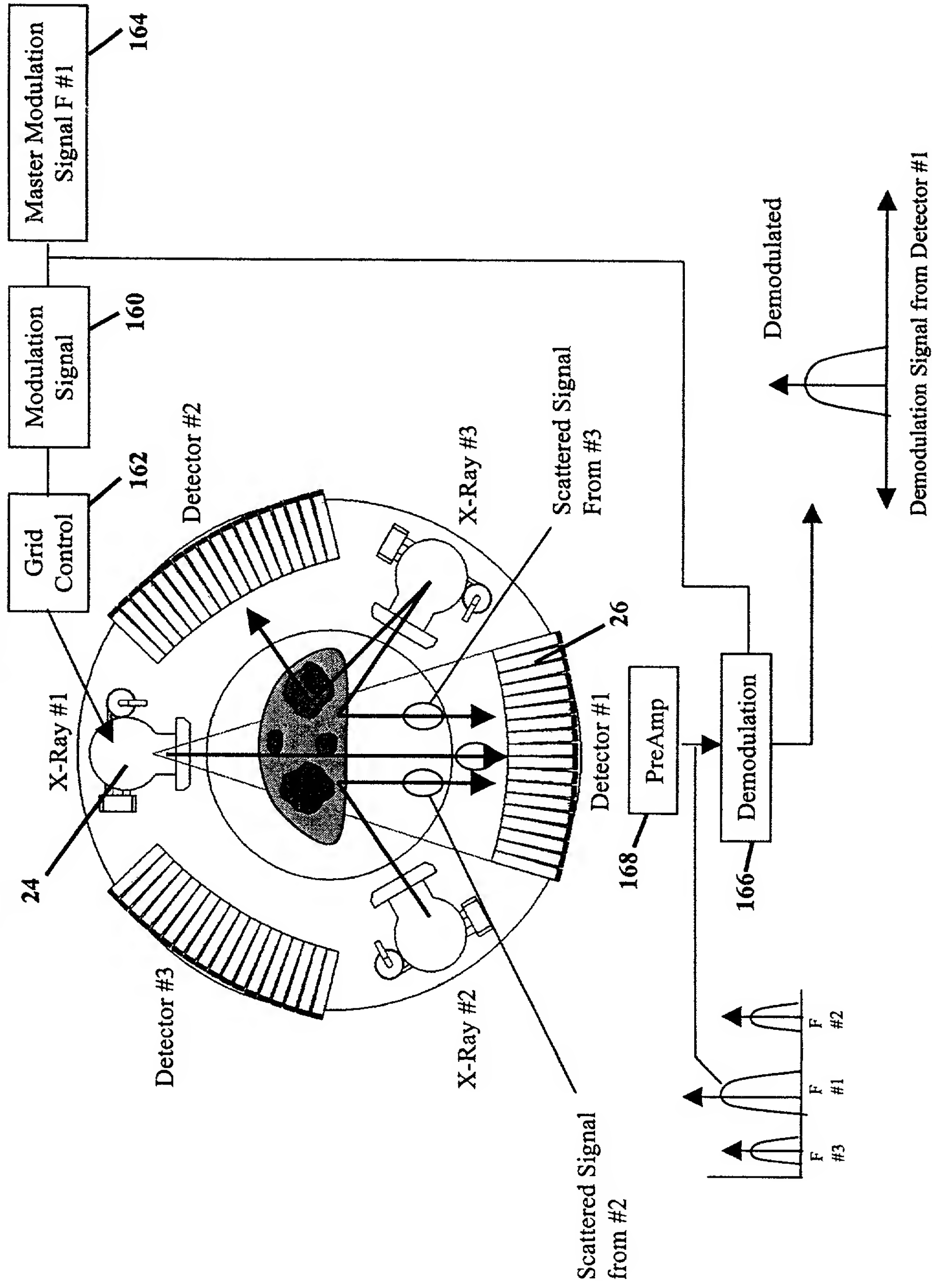


Figure 22

# Step and Shoot VCT Imaging

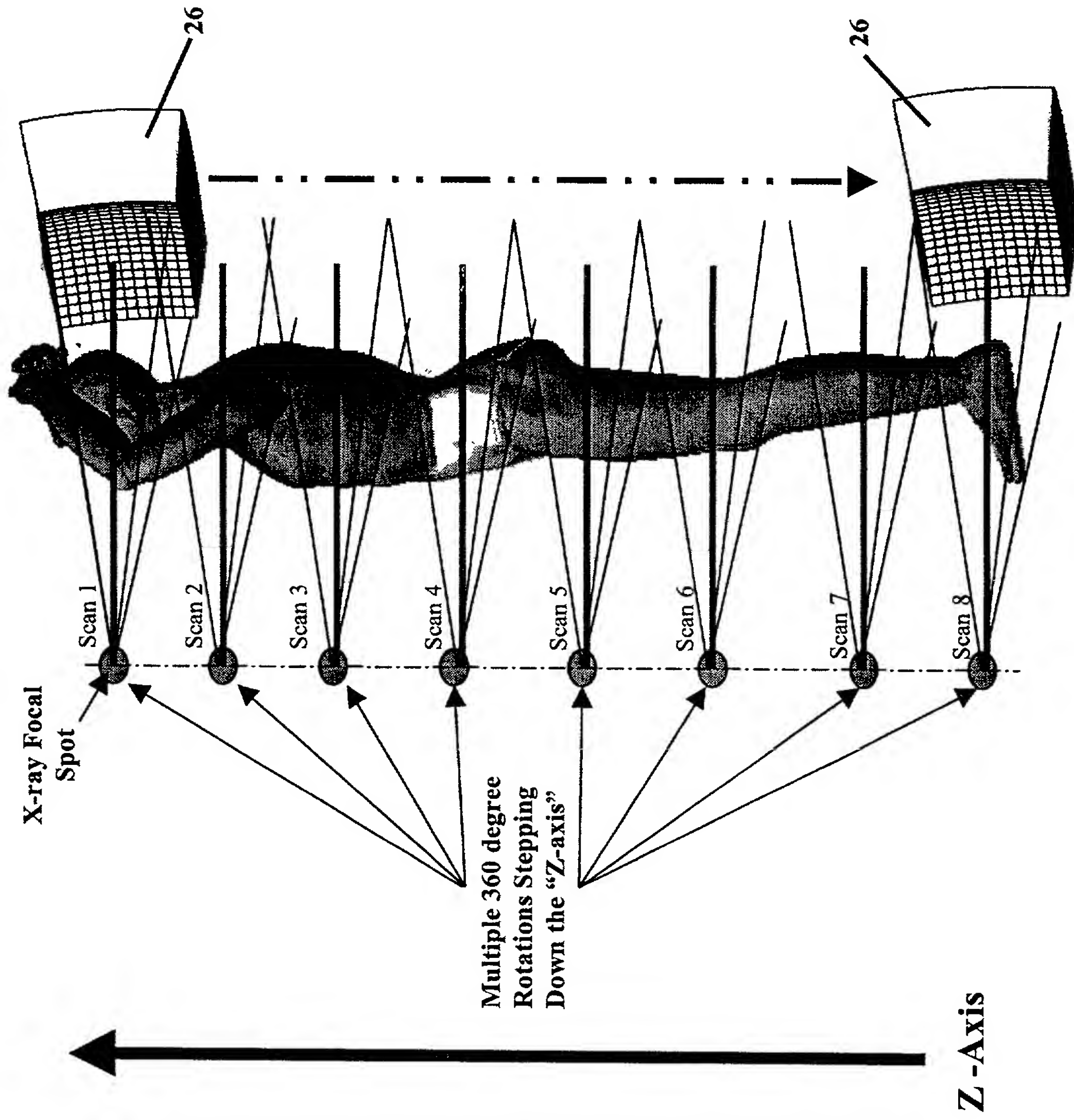
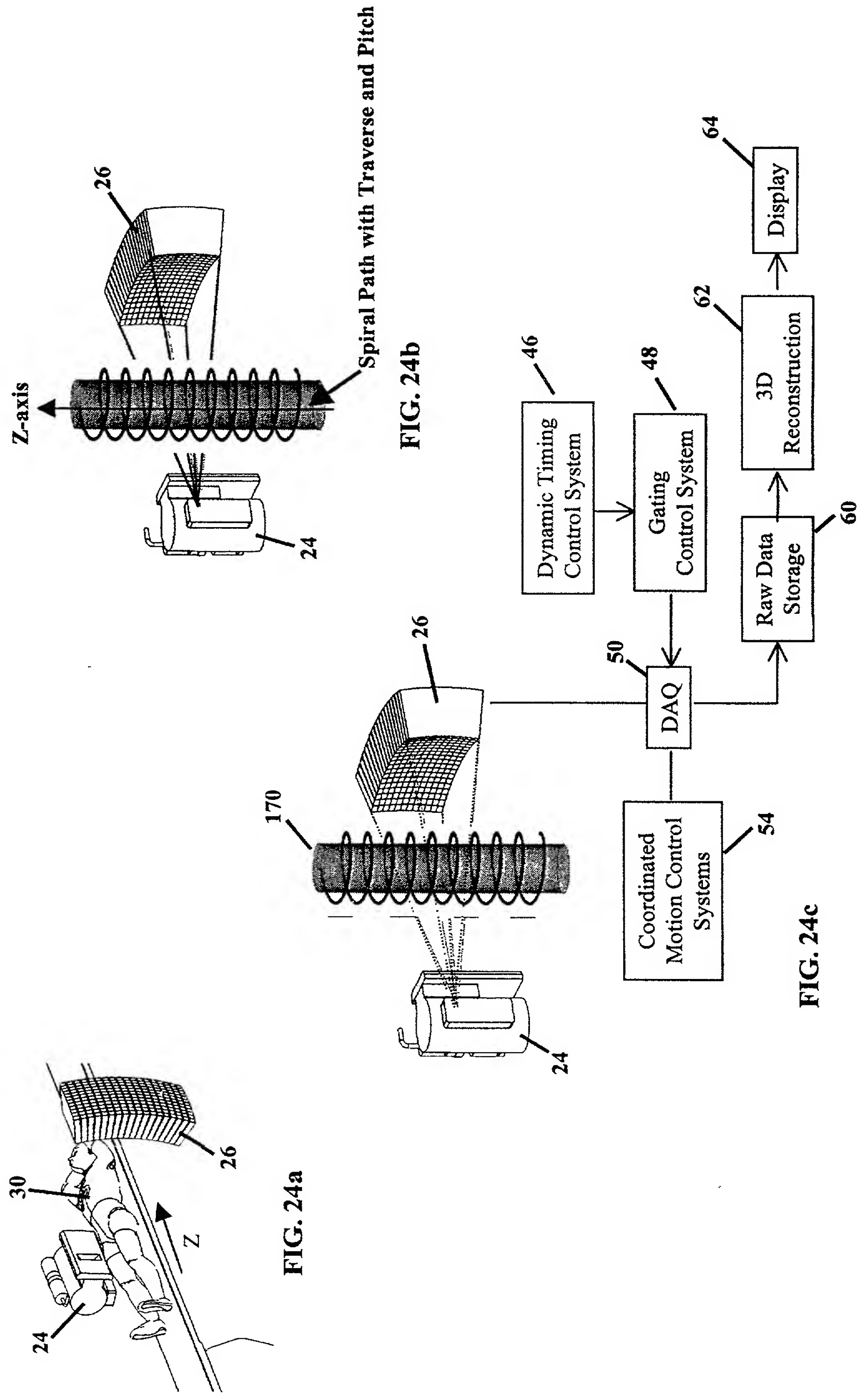


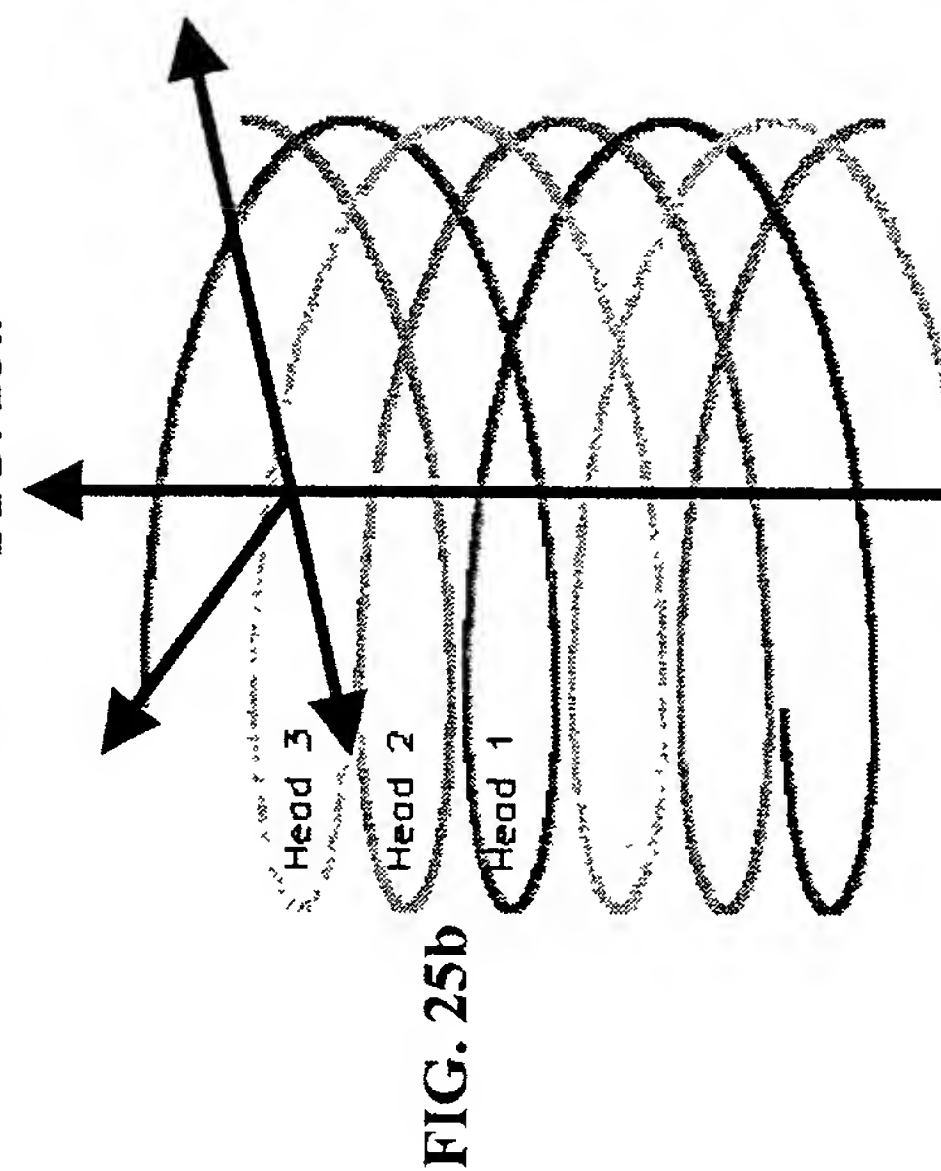
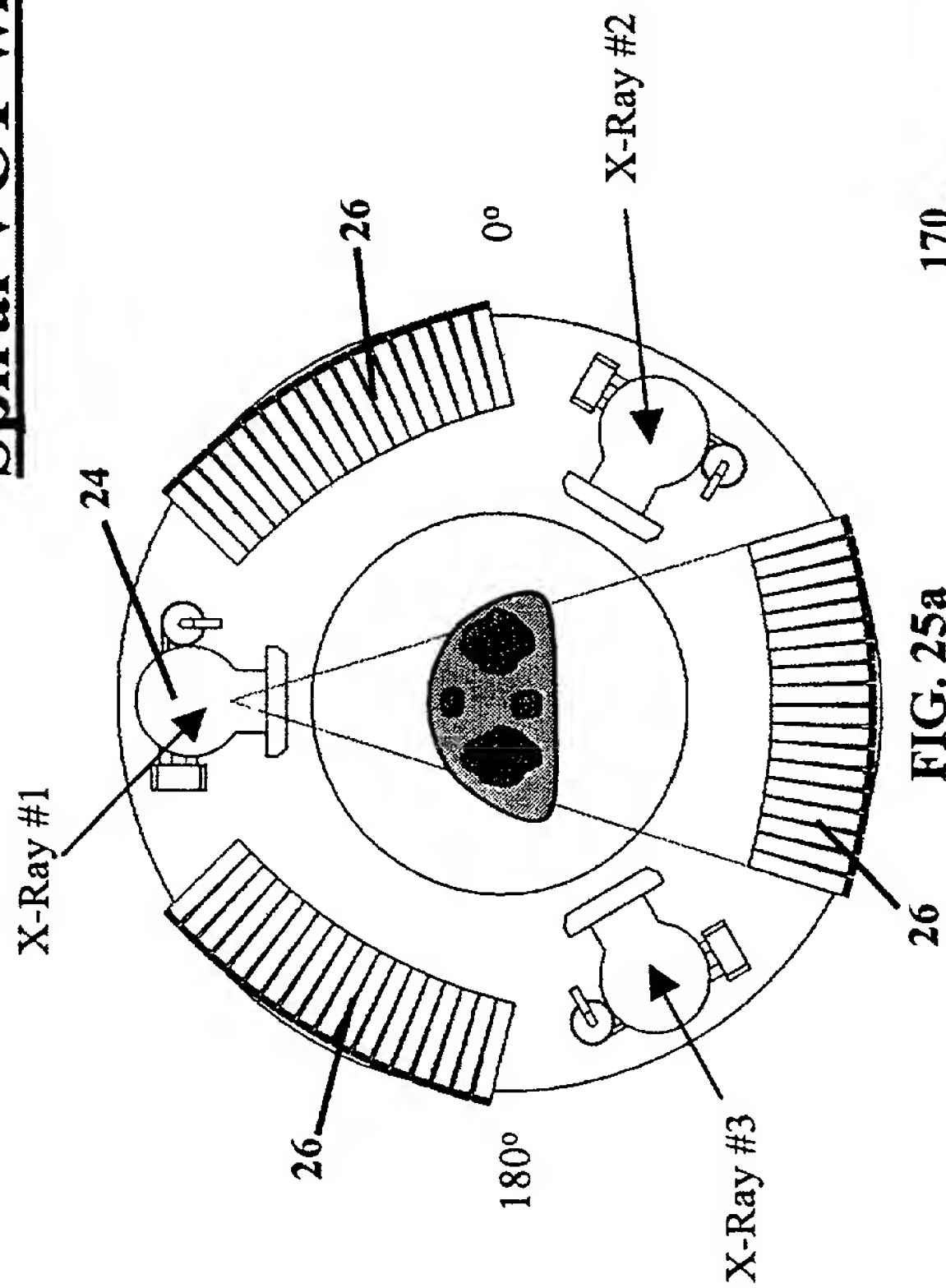
Figure 23



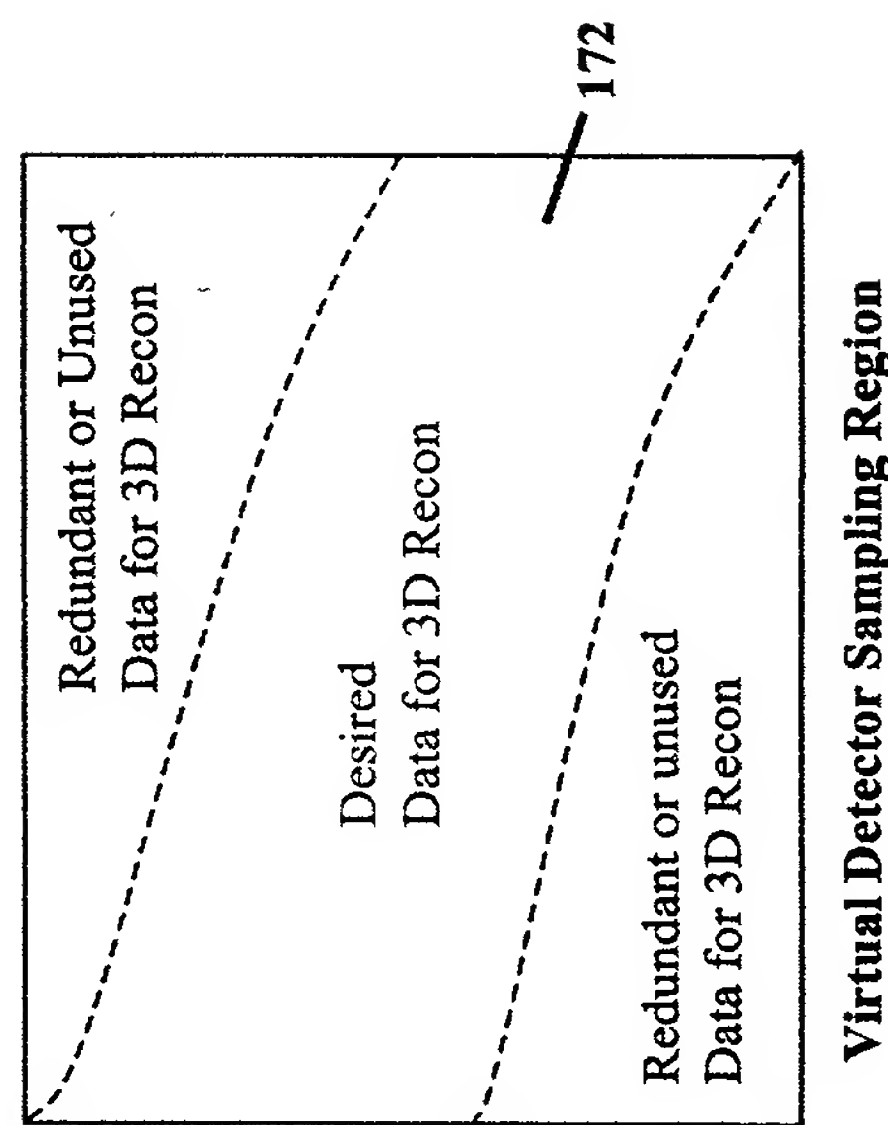
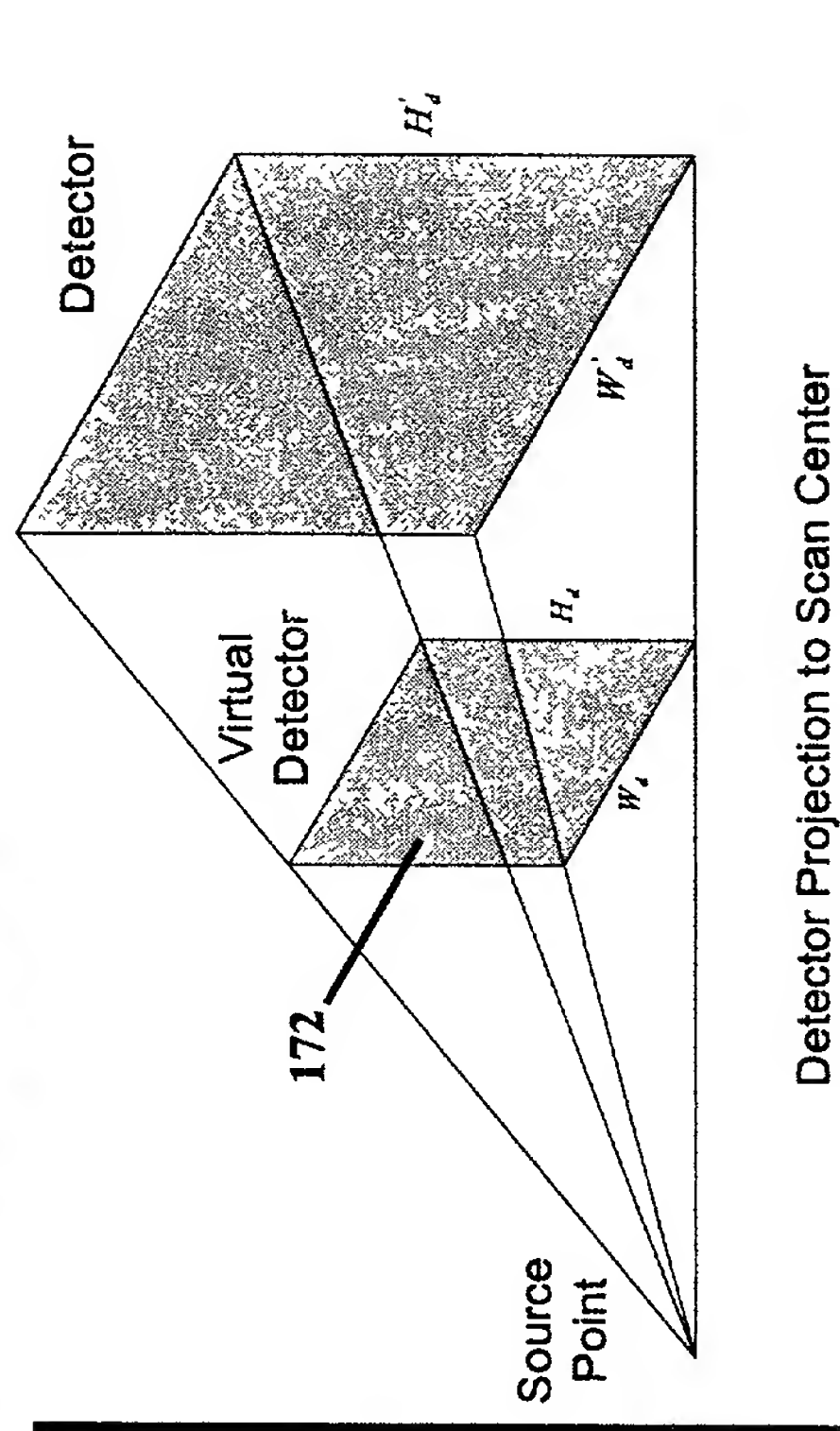
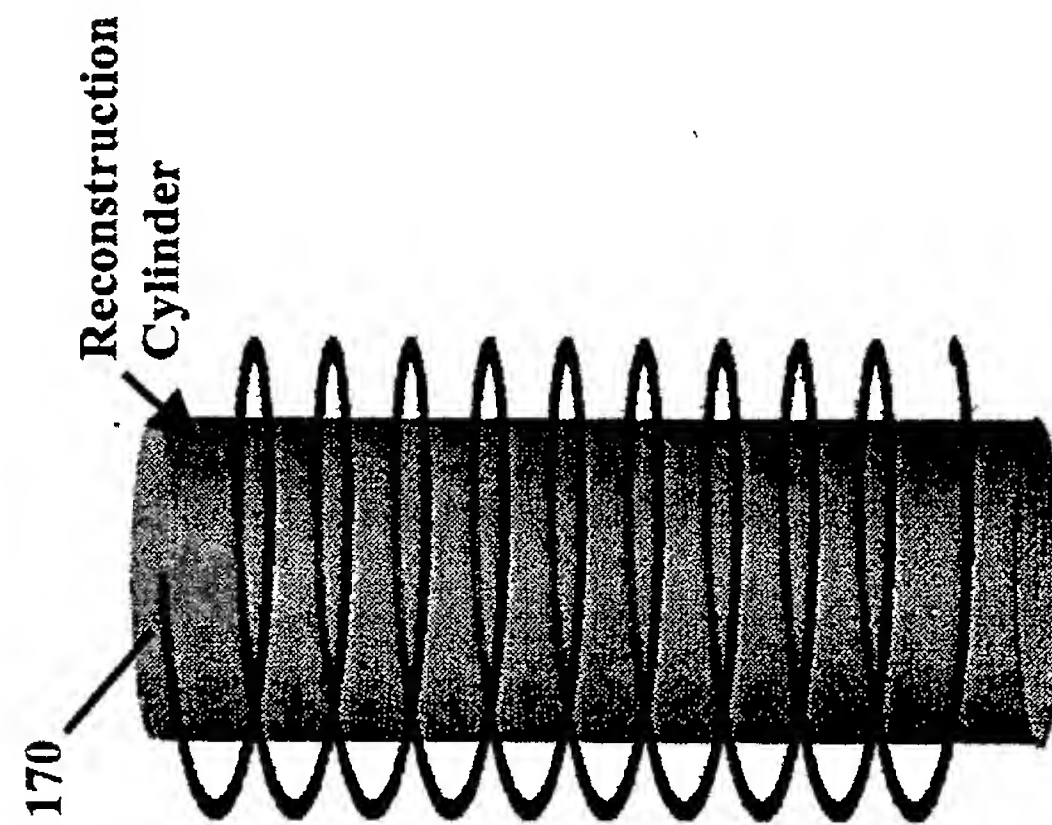
# **Spiral 3D X-Ray, DAQ and VCT for Cone Beam Reconstruction**



# **Spiral VCT with Multiple Heads**

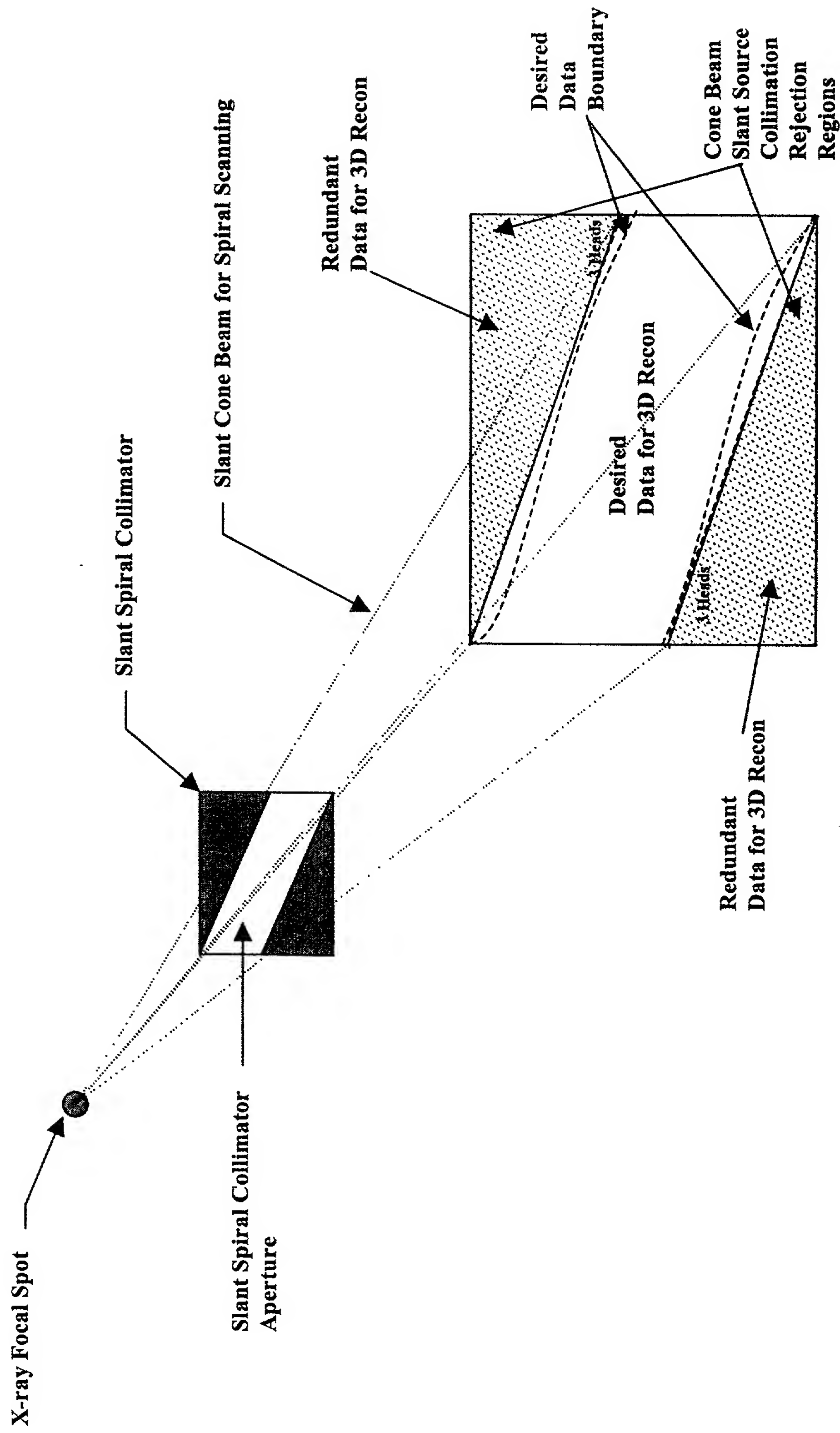


Spiral Path with 3 Heads with  
respective Central Rays on  
Reconstruction Cylinder



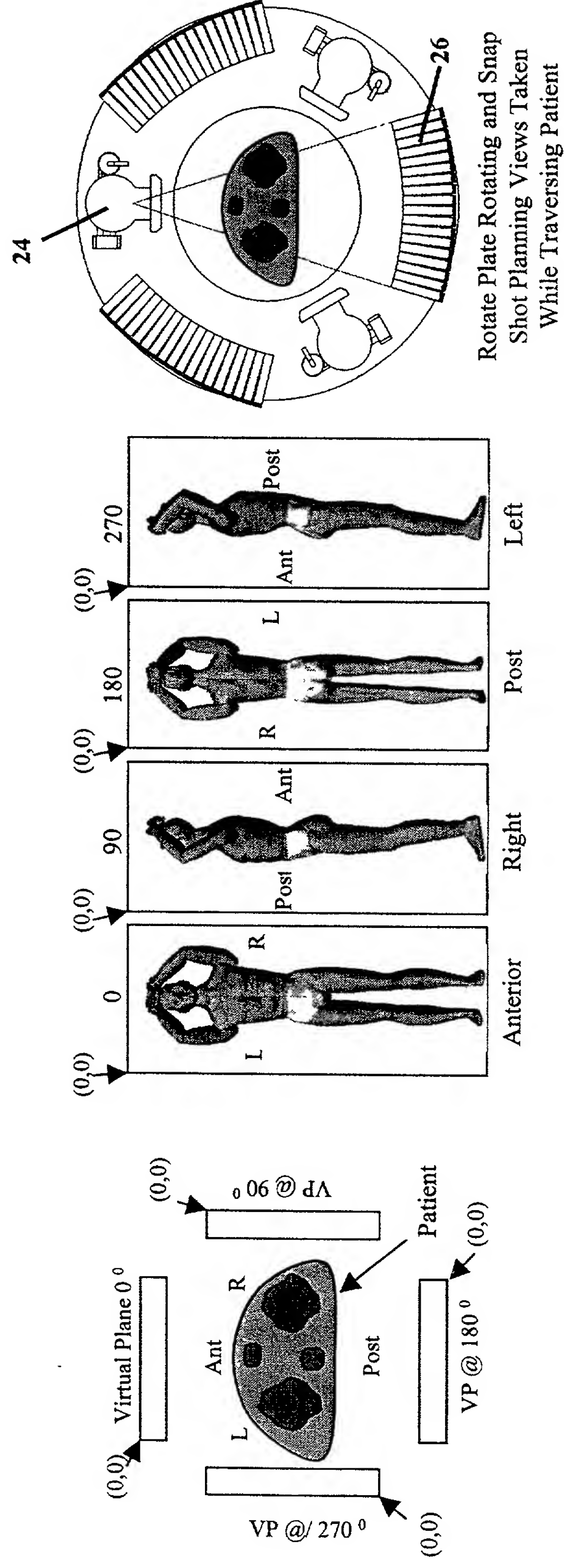
**Figure 25**

# **Cone Beam Slant Source Collimation for Spiral VCT Imaging**



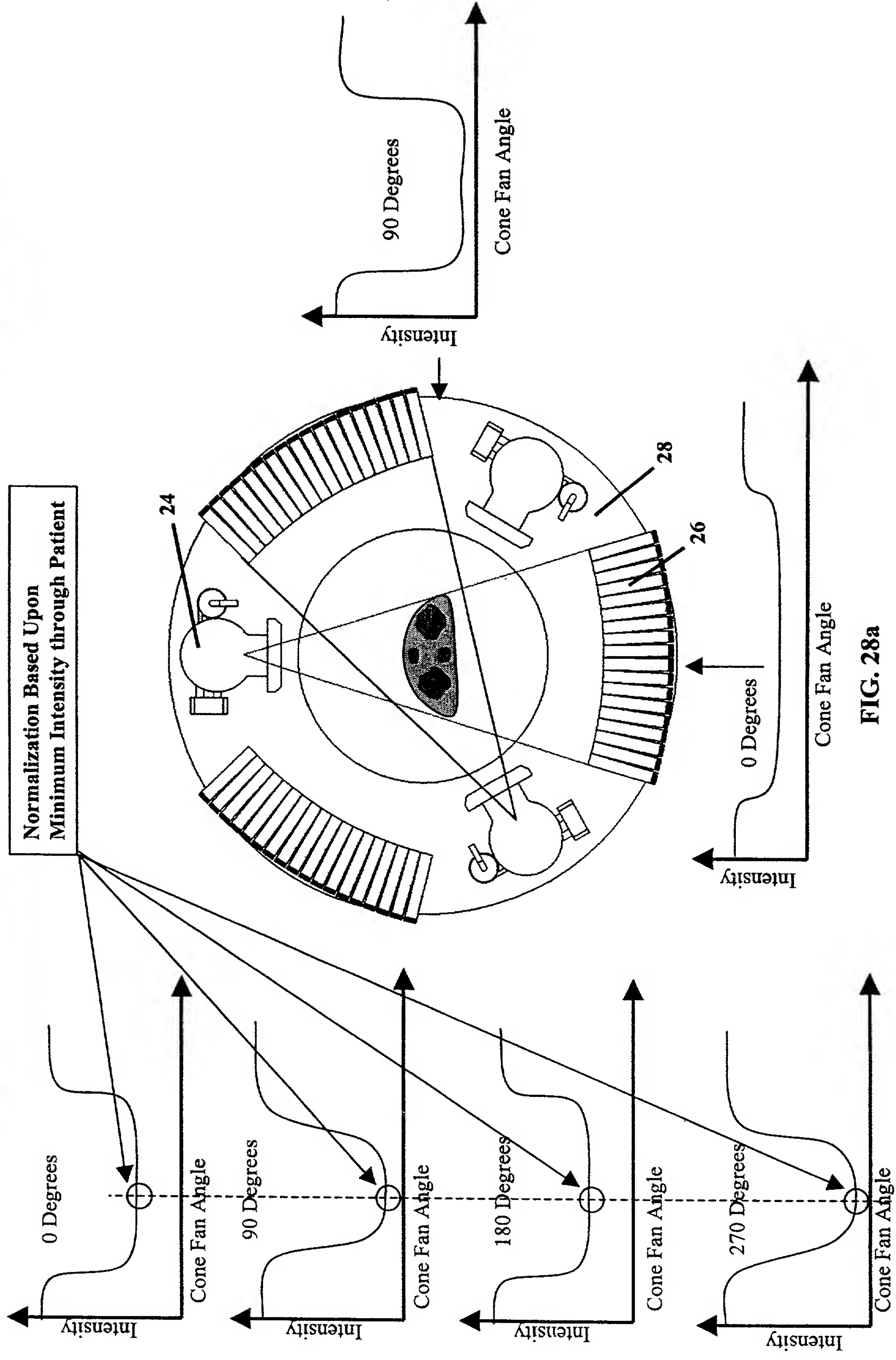
**Figure 26**

# Multi-Plane Planning System Imaging



### Figure 27

# Whole Body Dose Control From Planning System



## Figure 28

**FIG. 28b**



# Dynamic Timing Control

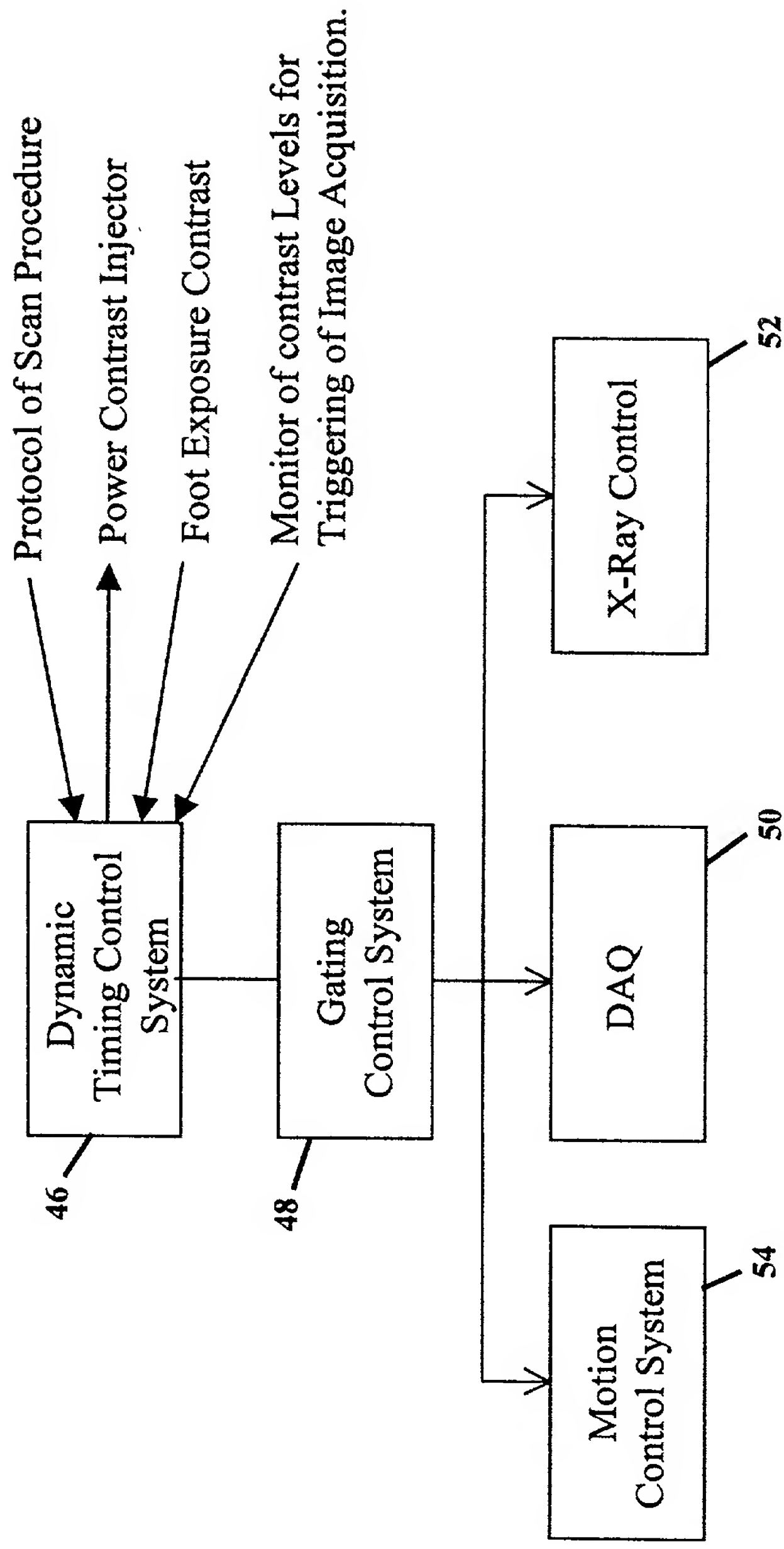


Figure 29

# Retrospective Gated Imaging System

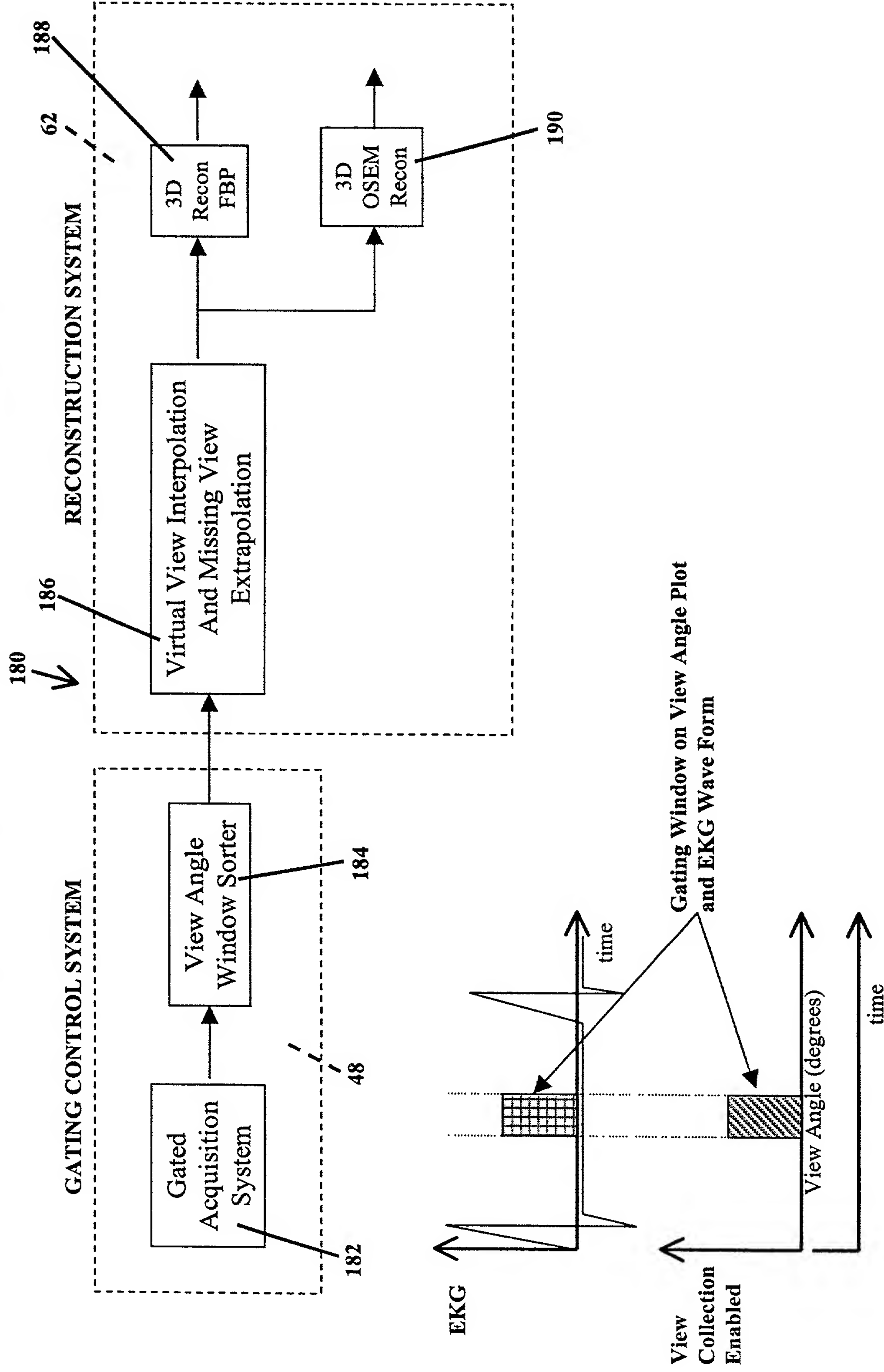
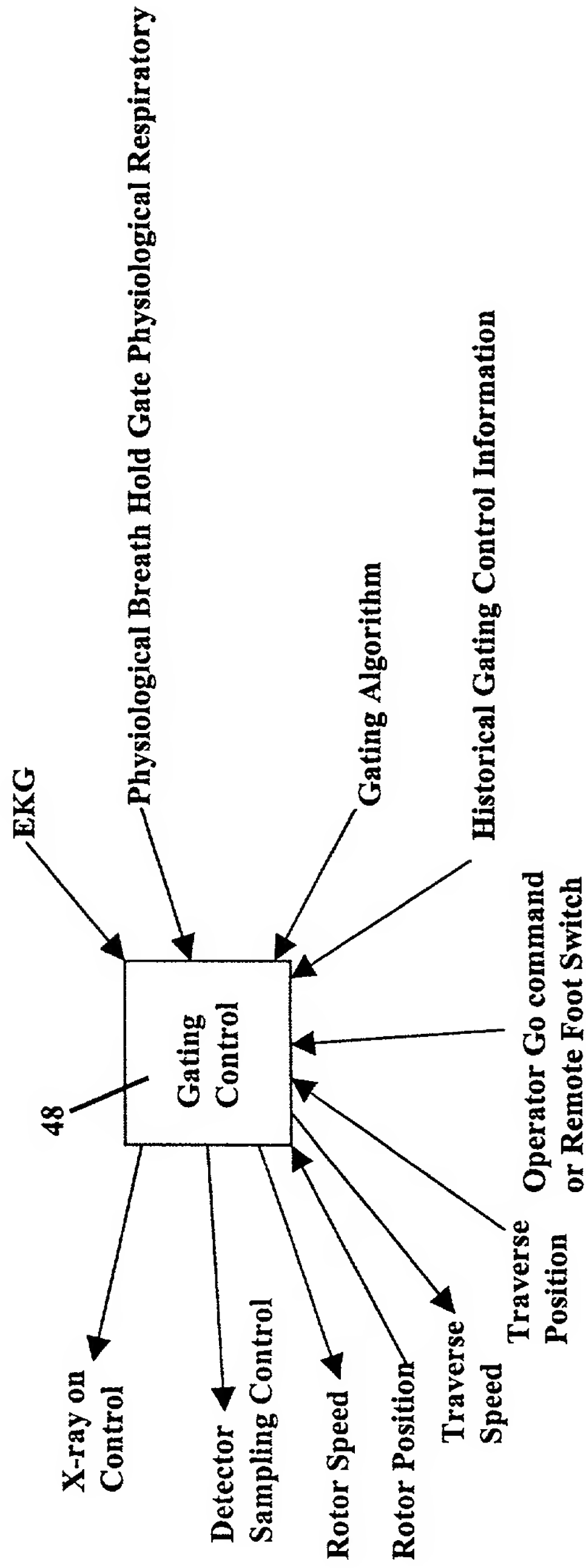
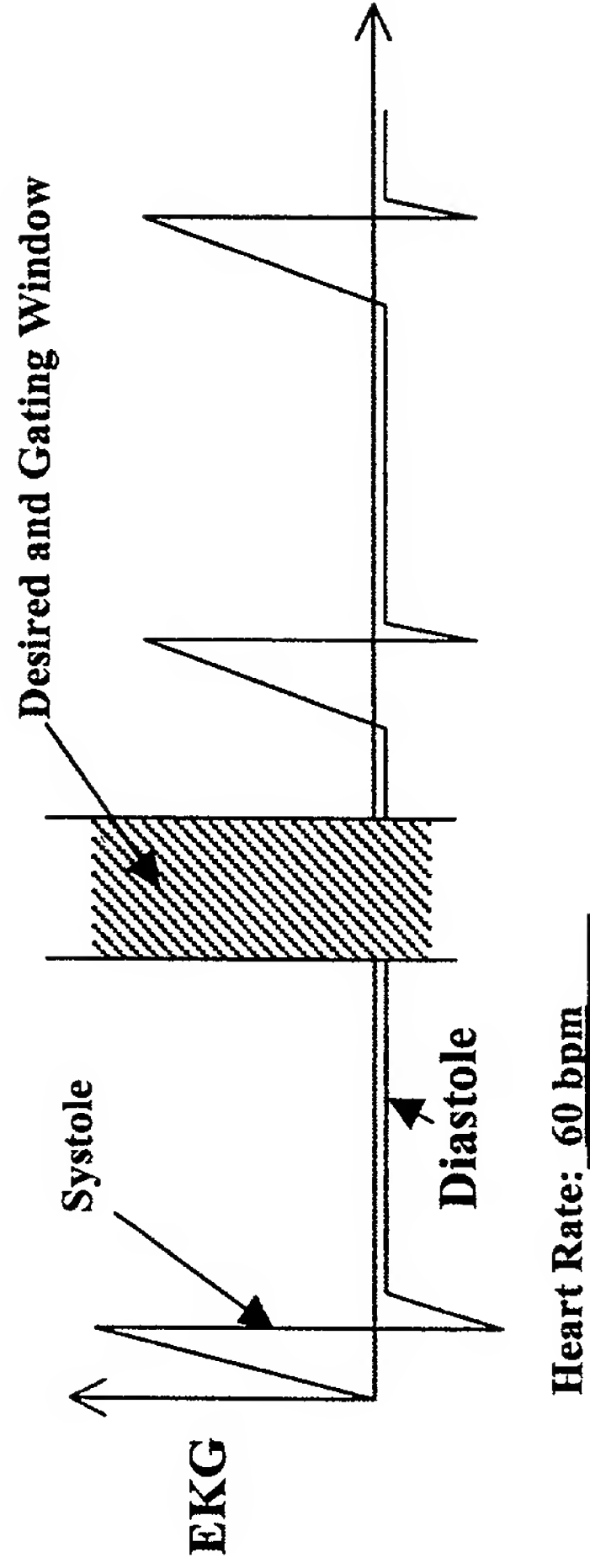


Figure 30

# Prospective Gating Control System with Cardiac EKG



**Figure 31**

# Prospective and Retrospective Gated DAQ and Reconstruction Imaging

## Prospective Gating Control

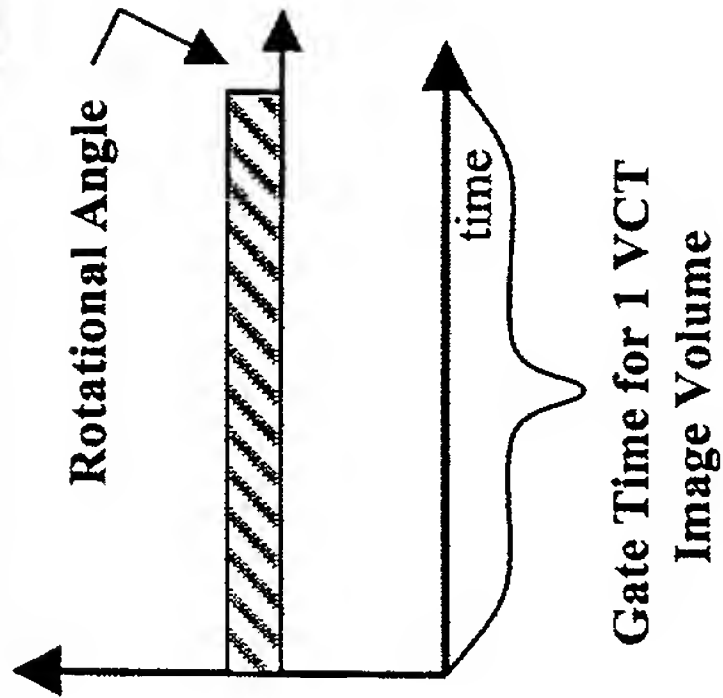


FIG. 32a

## Retrospective Gating Control

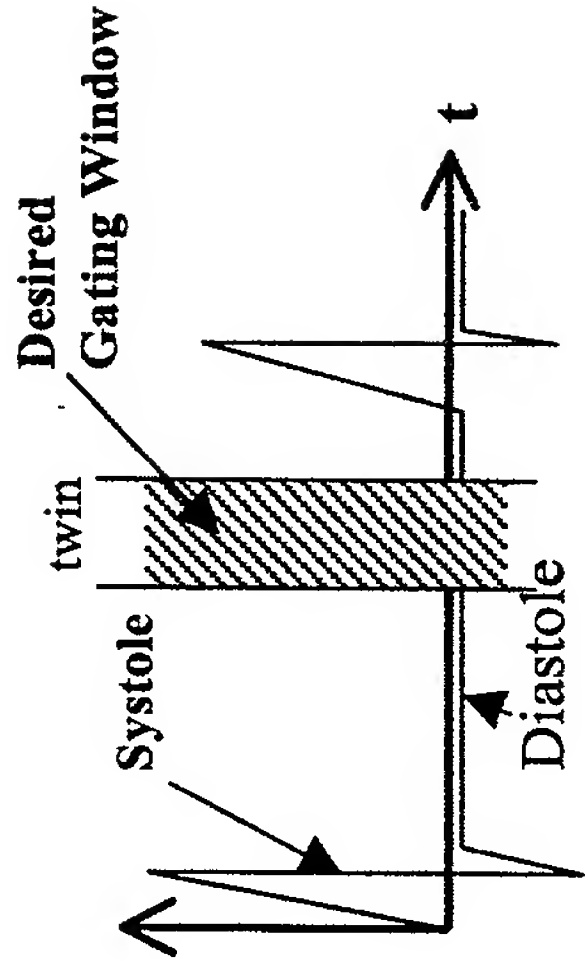
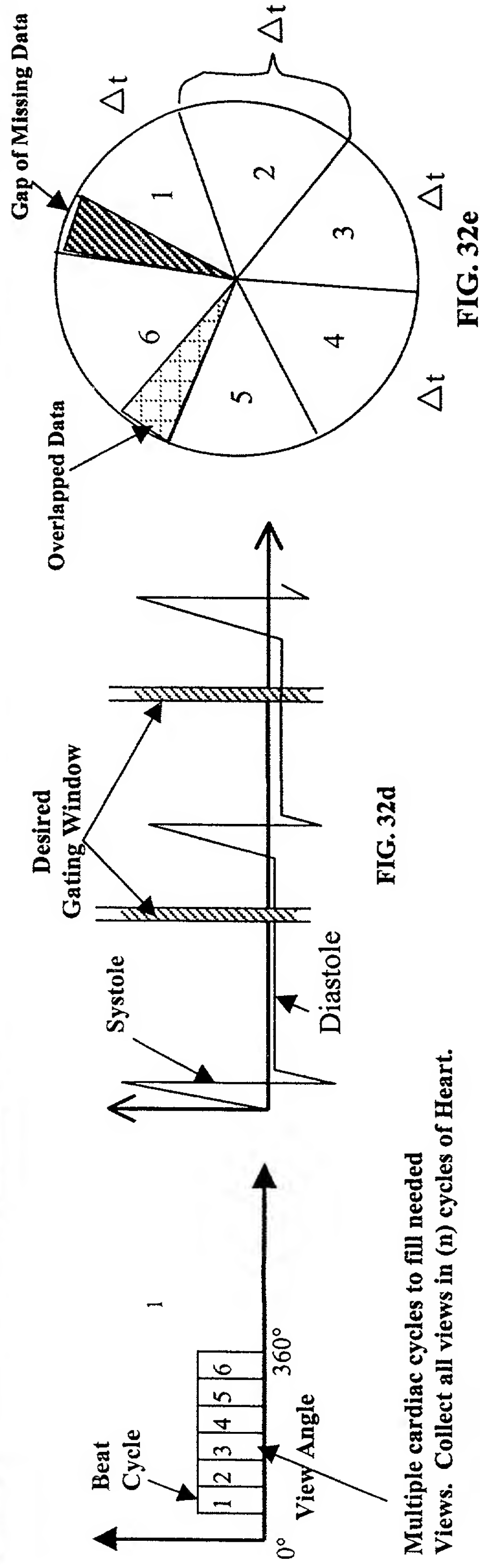


FIG. 32b

## Multi Cycle – Contiguous



Multiple cardiac cycles to fill needed Views. Collect all views in (n) cycles of Heart.

FIG. 32c

Figure 32

# Gated DAQ and Reconstruction for Retrospective Cine' Dynamic

## Cardiac Imaging

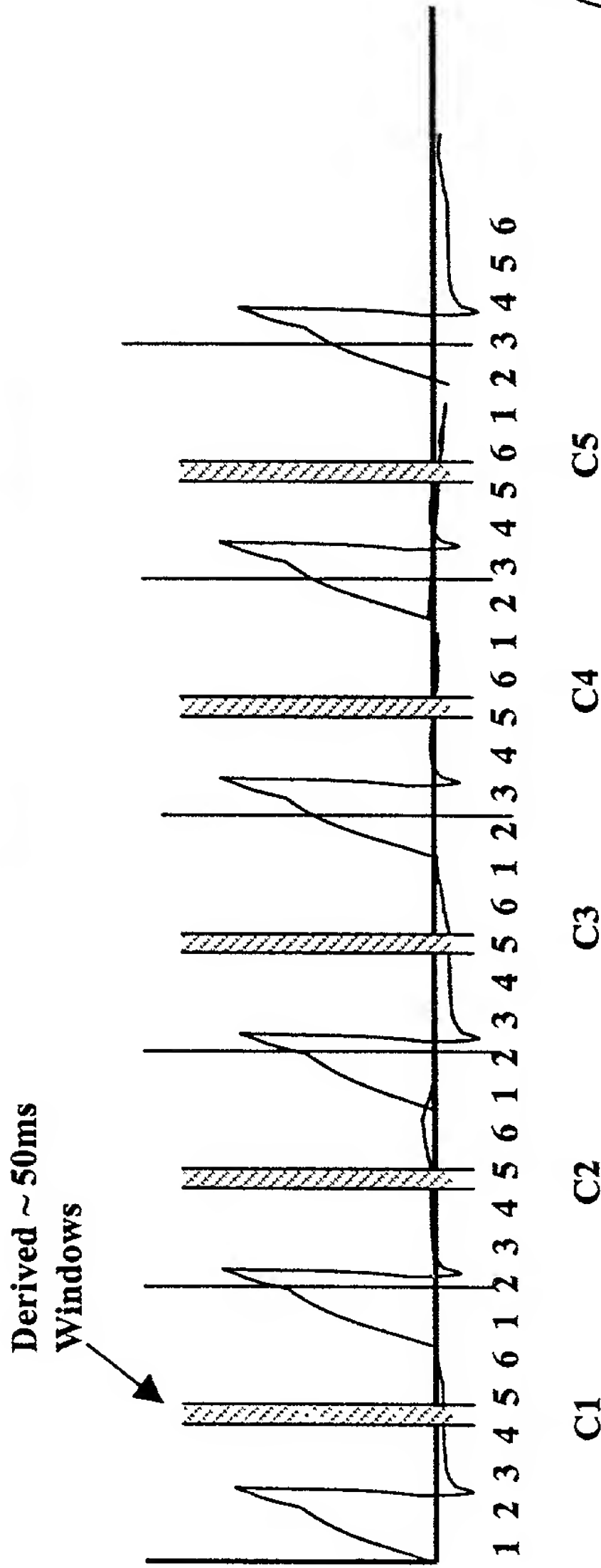


FIG. 33a

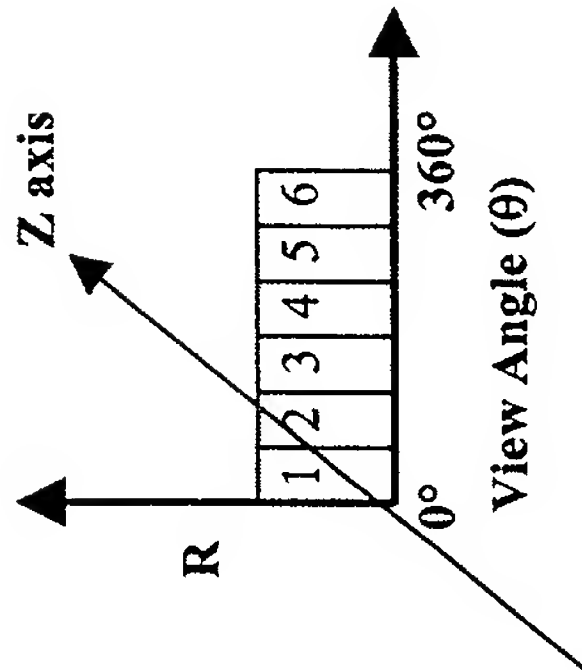


FIG. 33b

Views or  $\theta/\text{sec} = 360^\circ / .25 = 1440^\circ/\text{sec}$   
 $\frac{1}{2}^\circ$  View Spacing = 2880 views/sec

Desired Window: 50ms  
 In One Window:  $2880 \times 5 \times 10^{-2} = 144$  views  
 72 degrees

3 cycles for  $180^\circ$   $3 \times 72 = 216^\circ$   
 5 cycles for  $360^\circ$

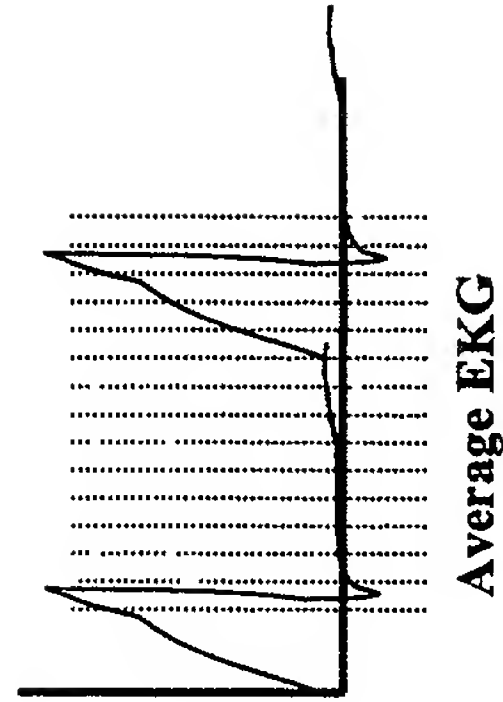
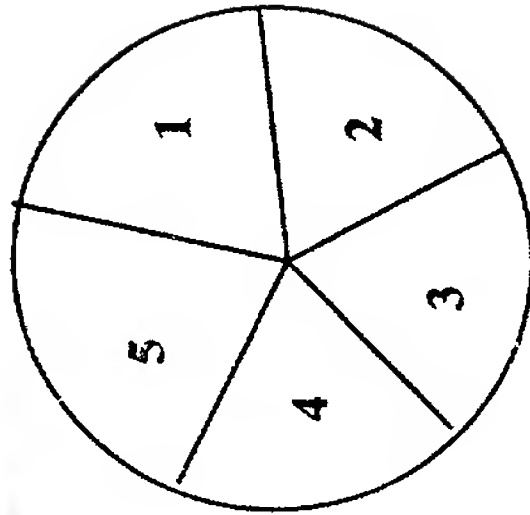


FIG. 33c

Figure 33



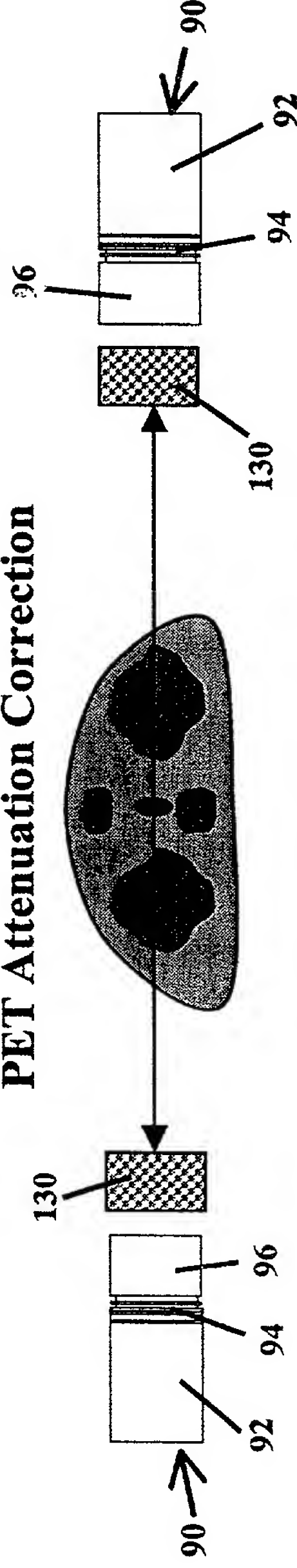
# PET Transmission, Attenuation & Scatter Correction

## VCT Attenuation MAP



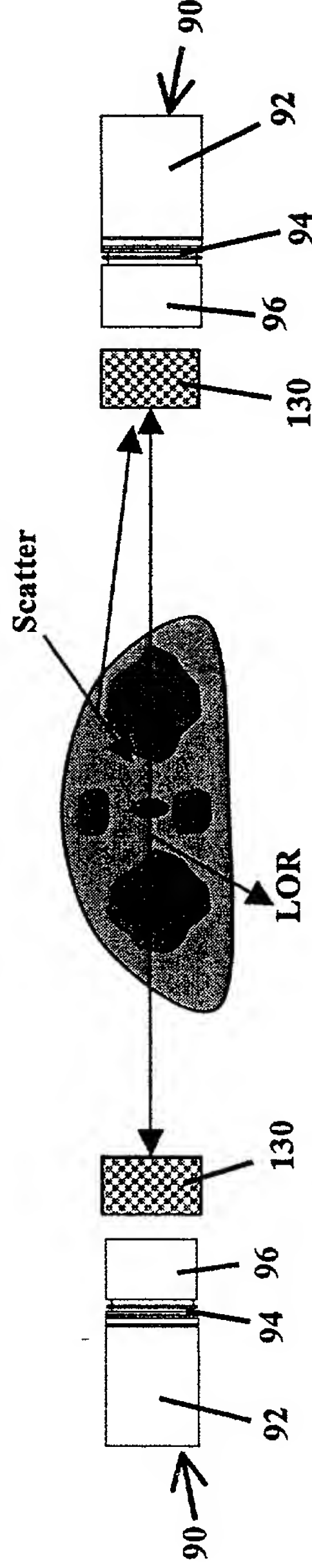
Transmission Attenuation  
Map at 511 KEV Energy Level from VCT Images

## PET Attenuation Correction



Correction Map for PET New Corrected PET  
Projections for OSEM Recon.

## PET Scatter Correction



Scatter Correction from VCT Images and  
Count Rates on a Projection View Basis

Figure 34

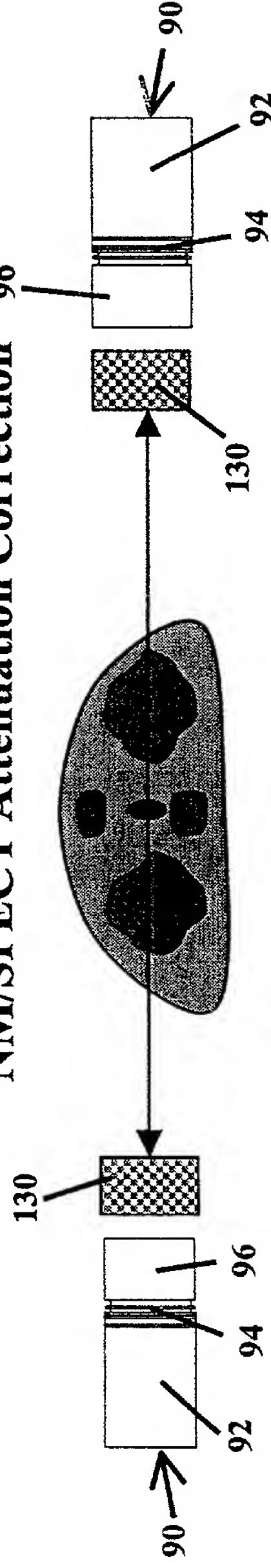
# **NM/SPECT Transmission, Attenuation & Scatter Correction**

## **VCT Attenuation MAP**



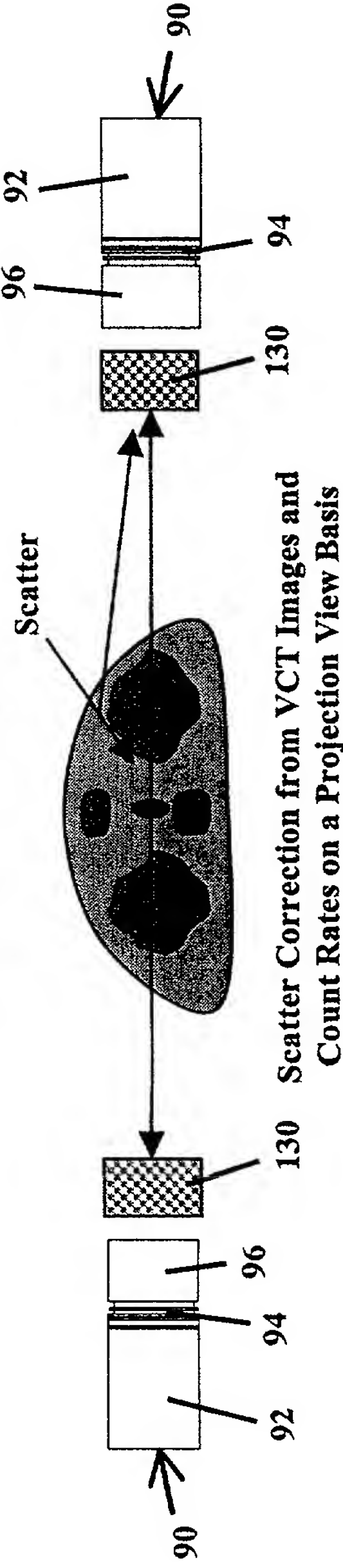
Transmission Attenuation  
Map at NM/SPECT Energy Levels from VCT Images

## **NM/SPECT Attenuation Correction**



Correction Map for NM/SPECT New Corrected  
SPECT Projections for OSEM Recon.

## **Scatter Correction**



Scatter Correction from VCT Images and  
Count Rates on a Projection View Basis

**Figure 35**

# Patient Fused Multi-Modality Imaging and Analysis System

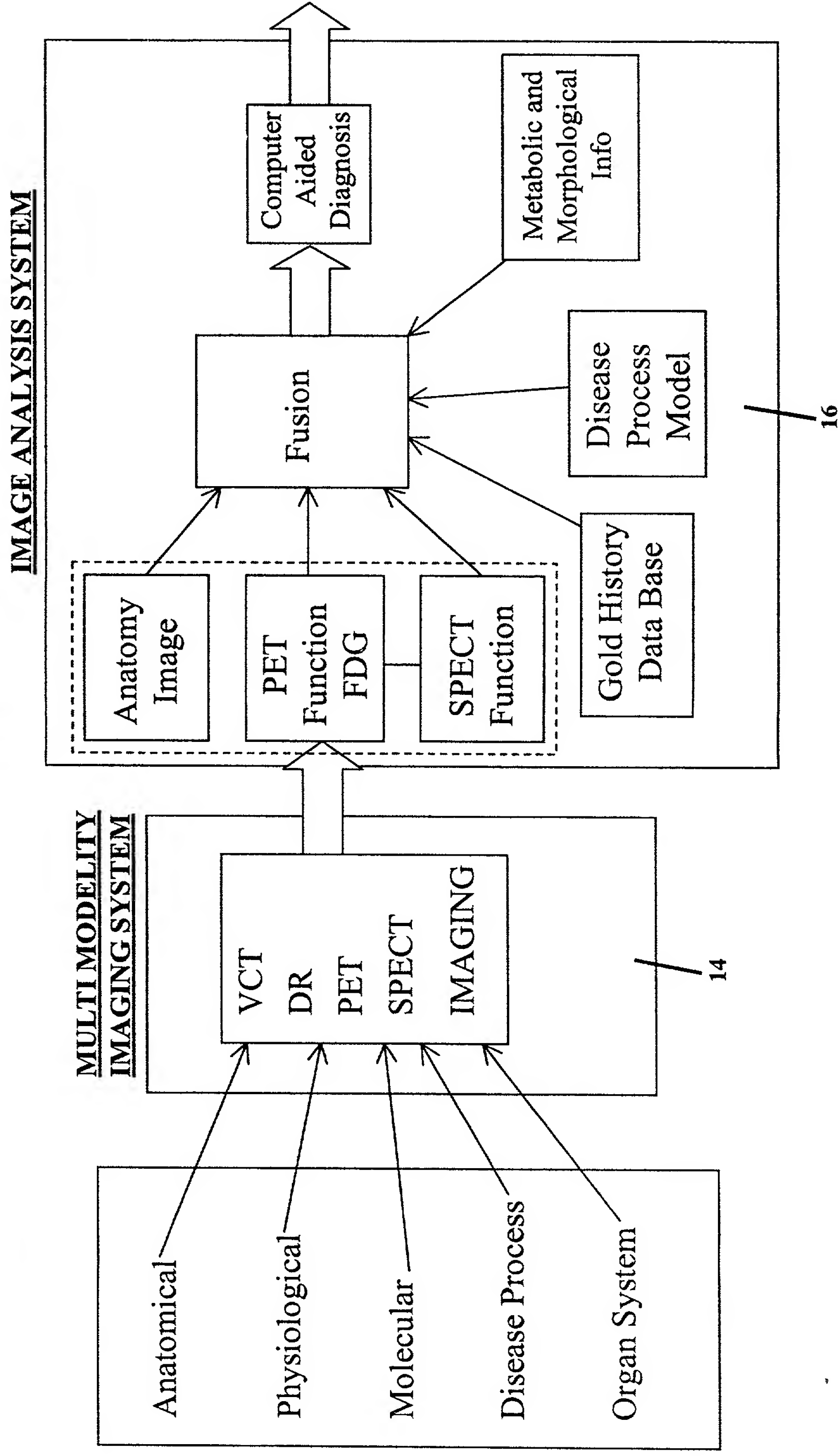


Figure 36

# Interventional Image Control System

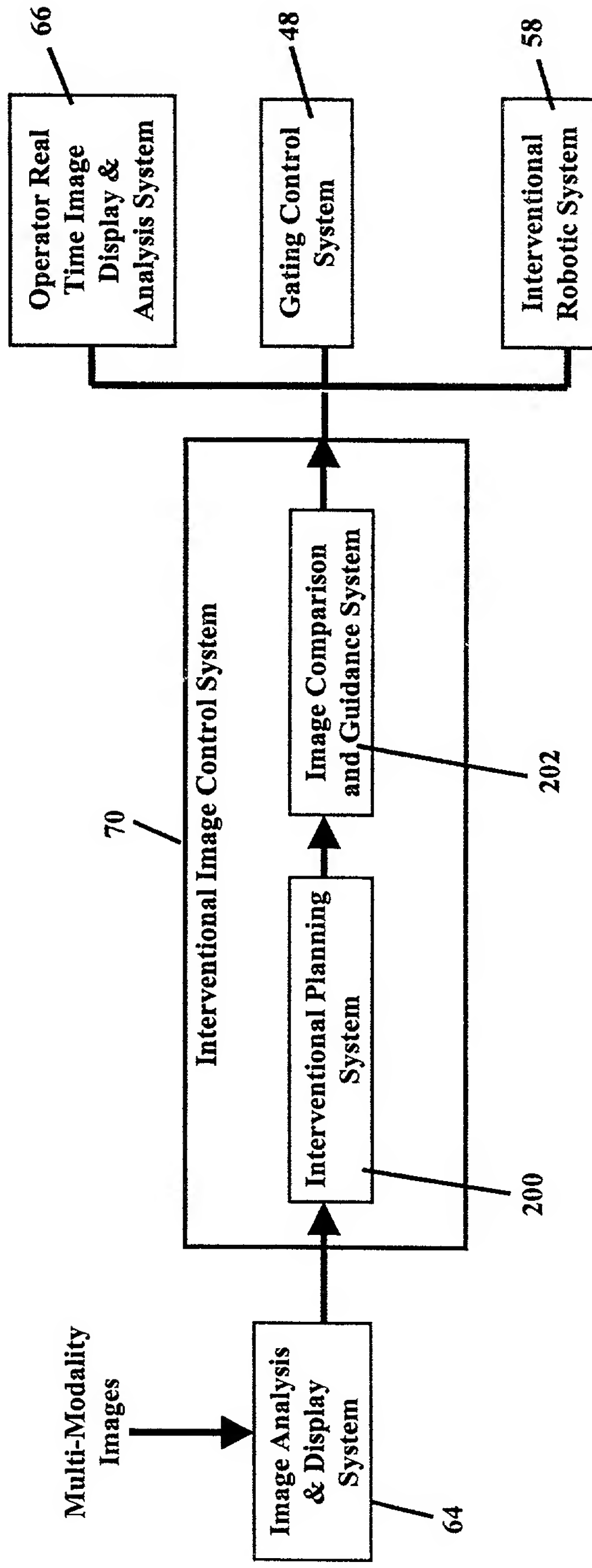
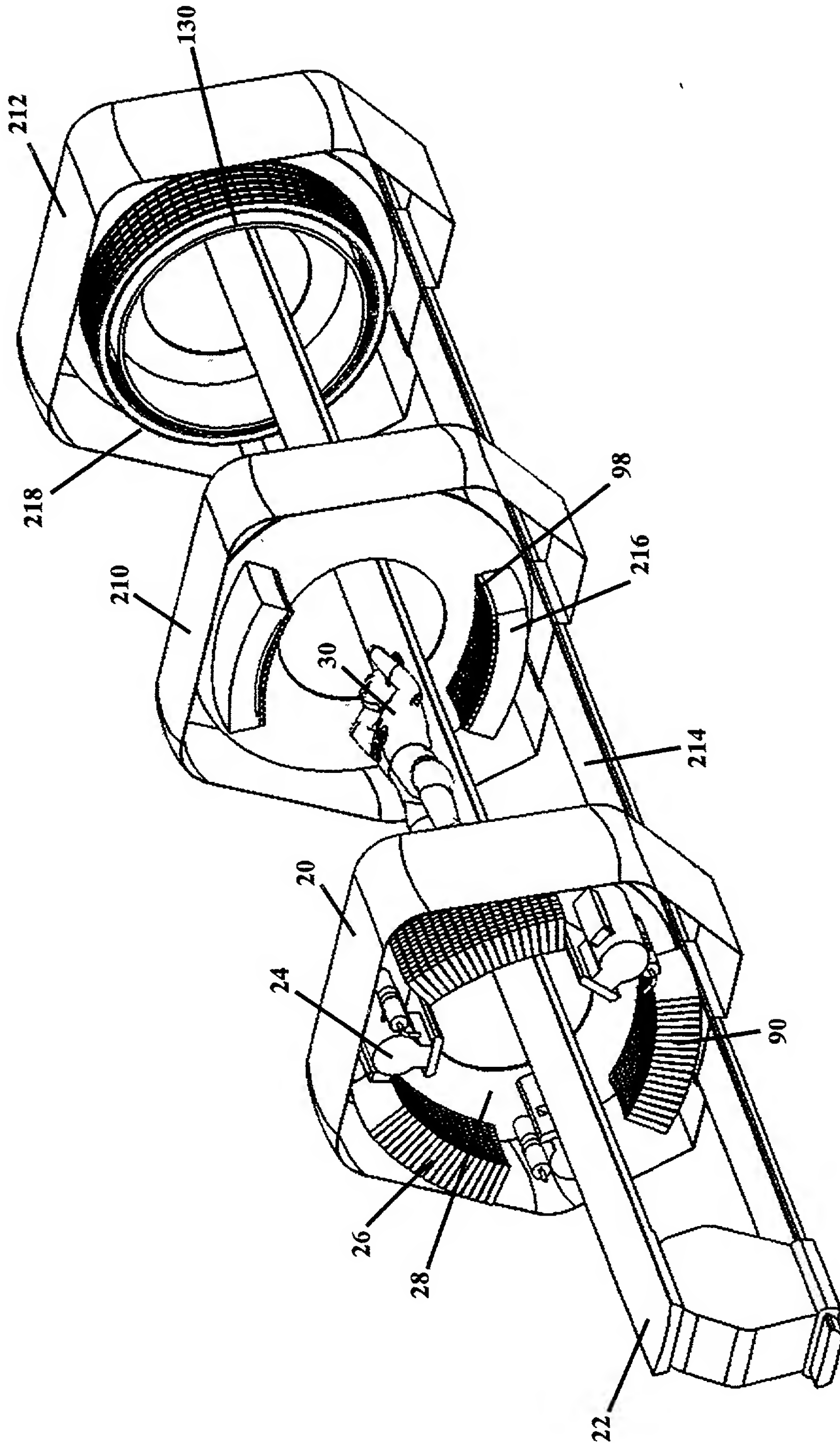


Figure 37

**Multi-Modality Imaging with Independent X-Ray VCT, PET, and  
NM/SPECT Image Acquisition System**



**Figure 38**





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# Multi-Modality Imaging with Independent X-Ray 4<sup>th</sup> Generation VCT, PET, and NM/SPECT Image Acquisition System

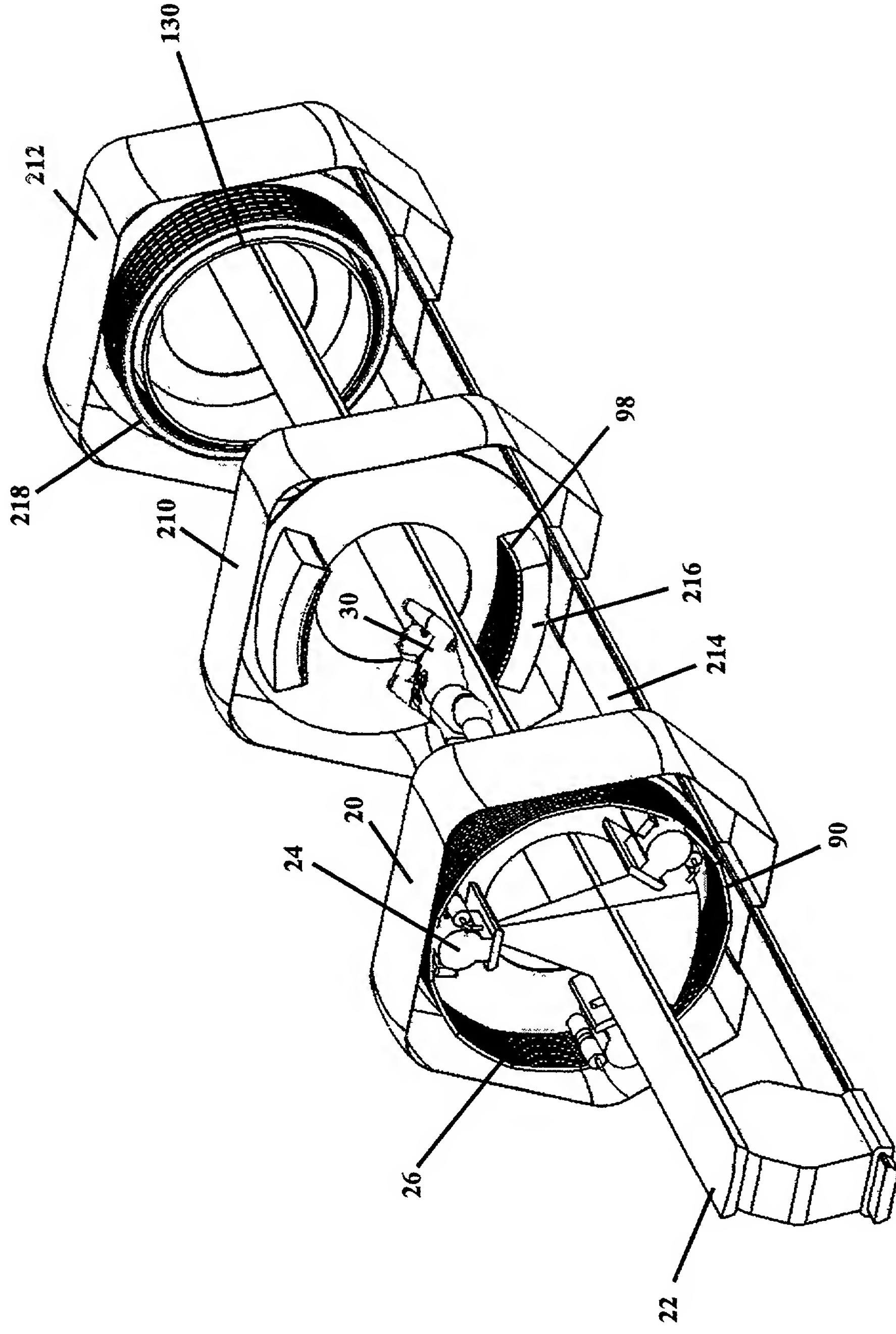
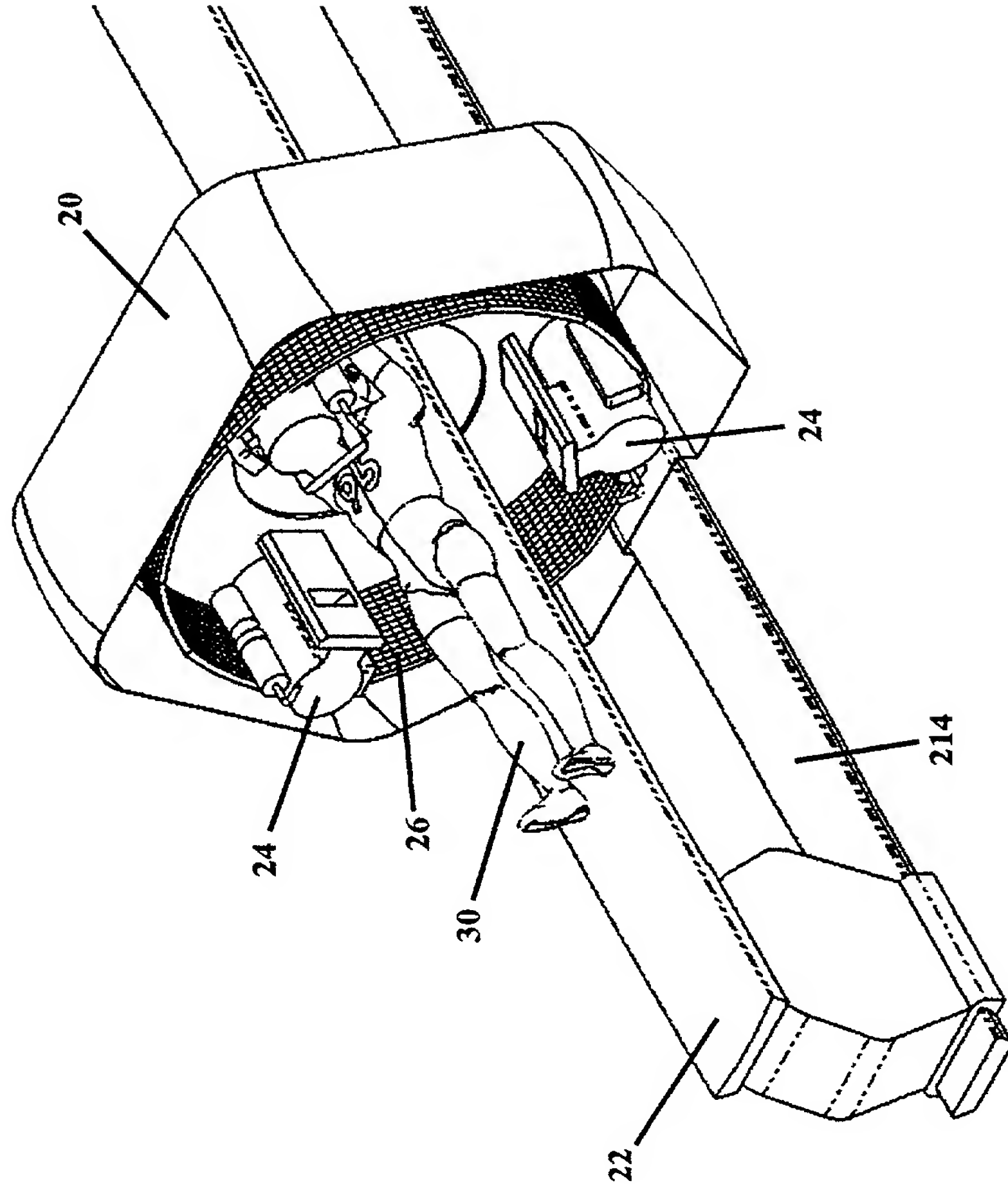


Figure 40

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**Multi-Modality Imaging System with Stationary  
Focused 2D Curved Detector for VCT, PET and NM/SPECT Imaging**



**Figure 41**

# Multi-Modality Imaging with Common Gantry and Independent X-Ray VCT, PET, and NM/SPECT Image Acquisition System

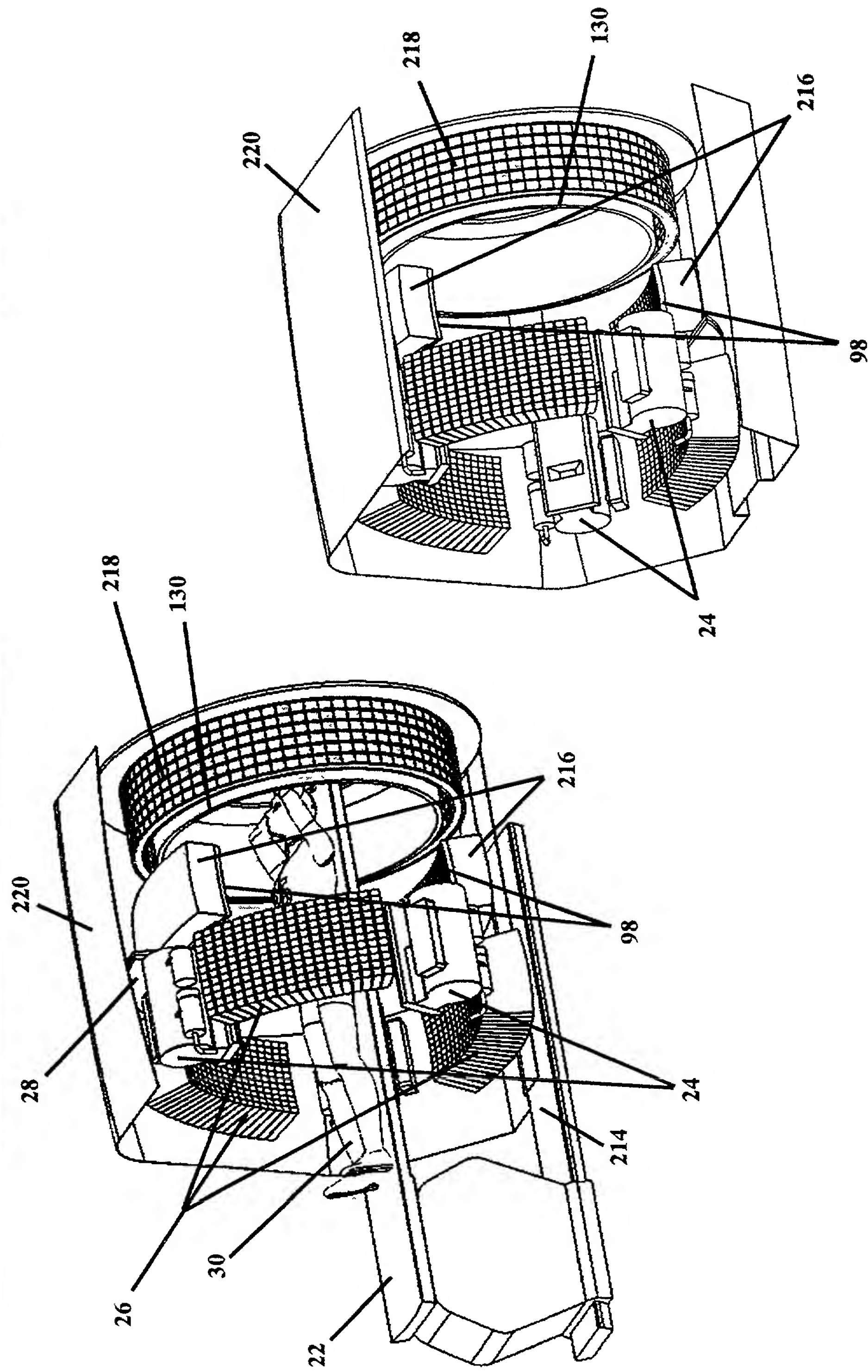
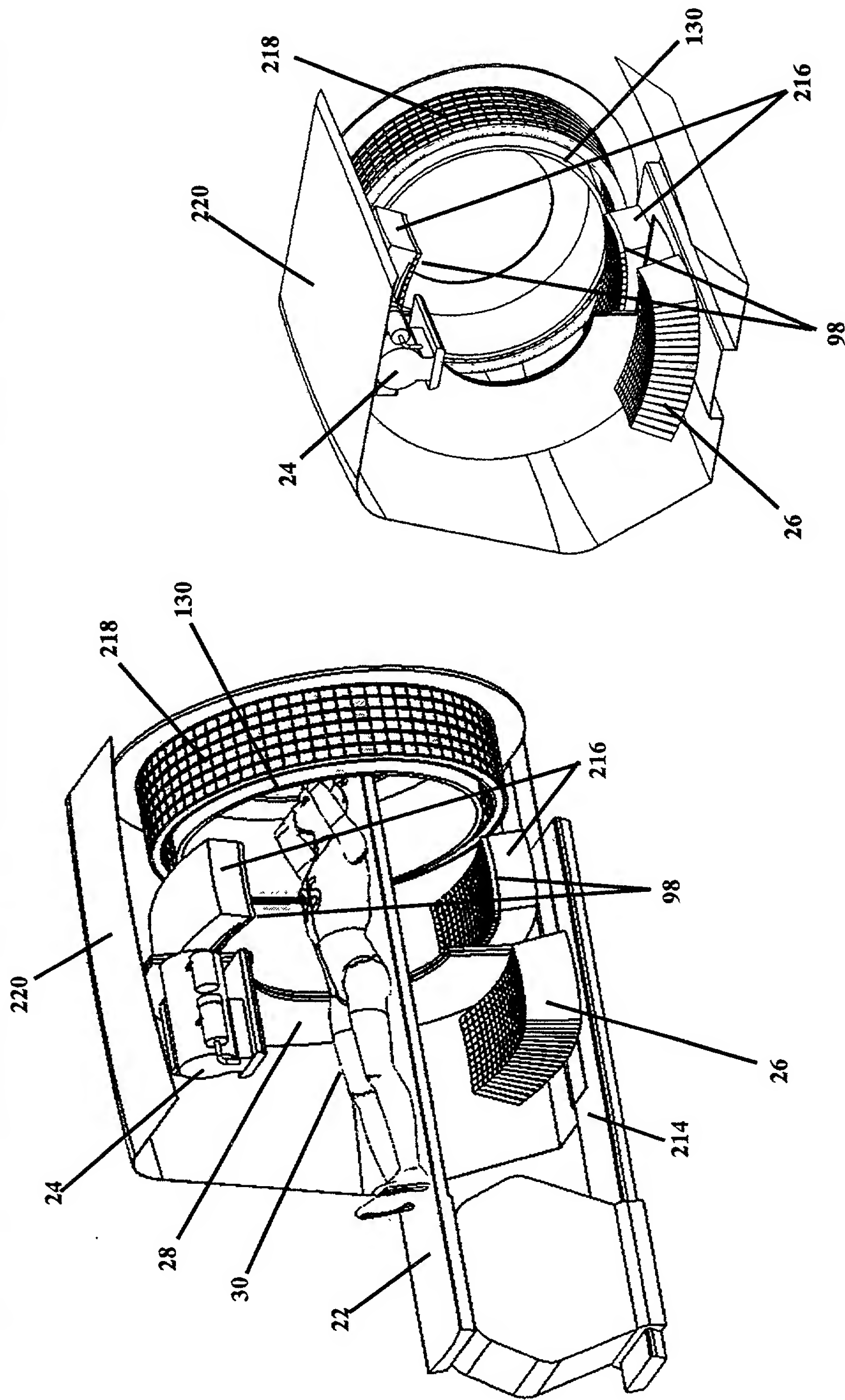


Figure 42

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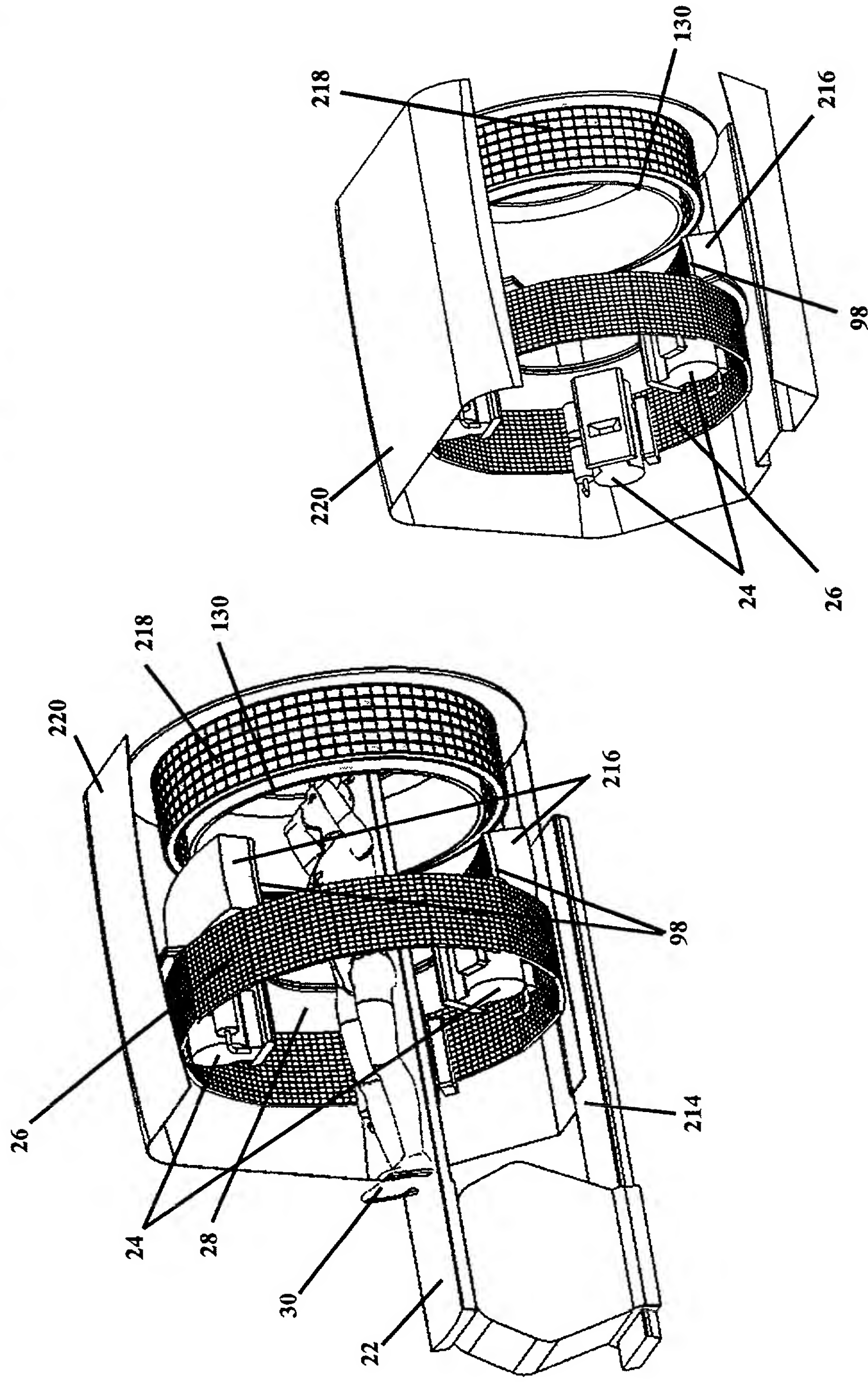
# **Multi-Modality Imaging with Common Gantry and Independent X-Ray Single Head VCT, PET, and NM/SPECT Image Acquisition System**



**Figure 43**

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# **Multi-Modality Imaging with Common Gantry and Independent X-Ray 4<sup>th</sup> Generation VCT, PET, and NM/SPECT Image Acquisition System**



**Figure 44**



